The Fish Communities and Populations of Long, Mica, Opinicon, Sydenham, and Upper Rideau Lakes, 1982.

Rideau Lakes
Fisheries Assessment Unit
Report No. 12

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Printed in Ontario, Canada
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Depletion (of fish stocks) is not, as frequently understood a condition either of recent origin or of temporary nature. ... It would be better to consider depletion as a process and to understand how reduction of native stocks begins in the first place in order to appreciate the nature of the final stage... .

.....

This process has been going on (since early travellers and pioneer settlers first arrived)... . It has been assisted by almost every influence that has come about in the course of social and industrial progress. We have only to run through the list - deforestation, navigation facilities, water supply, pollution, power development, tourist trade and what not - to see how the process of fish extermination works.

.....

Viewing the matter historically, we have (in the southwestern portion of the province) ... a relatively small area which ... sustained ... the first shock of industrial development and depletion.

.....

While this development was going on, and during its advanced stages in the last century, the waters immediately along and to the northward of the pre-Cambrian line began to be accessible and also desirable from the summer visitor's point of view.

The waters involved were the Muskoka Lakes, to some extent the Georgian Bay and the magnificent lakes and streams of the Trent and Rideau systems, ... together with the upper reaches of the St. Lawrence River ... . It is the same waters, generally speaking, that are now in critical condition.

.....

Depletion is a process of long duration which can and in all Ontario situations is likely to be greatly accelerated (in the future).

- excerpt from Macdiarmid F., B.A. Bensley and C.A. Candee. 1930. Report of Special Committee on the Game Fish Situation. Legislative Assembly of Ontario.Sessional Paper, No. 54. pp. 12-16. Printed and Published by Herbert H. Ball, Printer to the King's Most Excellent Majesty.

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ABSTRACT

In 1982, the Rideau Lakes Fisheries Assessment Unit initiated several long-term programs to monitor the fish communities and populations of the Unit's five warmwater type lakes. This report documents field procedures and methods of analysis and summarizes the community and population information derived for each lake.

Long Lake - Eleven fish species were captured in index trapnets at Long Lake: (in descending order of abundance) bluegill, pumpkinseed, rock bass, brown bullhead, yellow perch, largemouth bass, northern pike, smallmouth bass, yellow bullhead, white sucker, and golden shiner. The overall Shannon diversity index was 2.18.
Golden shiner was the only species captured in trapnets which did not occur in gillnet catches.
Age structure data indicates a high total mortality rate for smallmouth bass (ages 7-10) and largemouth bass (ages 6-9). Fork length-at-age data shows that these age groups coorespond to the size at which these species are legal for anglers to harvest (30 cm).

Mica Lake - Eight fish species were captured in index trapnets at Mica Lake: (in descending order of abundance) brown bullhead, pumpkinseed, yellow bullhead, bluegill, rock bass, northern pike, largemouth bass, and yellow perch. The overall Shannon diversity index was 1.77.
Largemouth bass was the only species captured in trapnets which did not occur in gillnet catches.
Northern pike was the only target species captured in sufficient numbers to allow a reasonable assessment of population characteristics. Growth was slow and mortality was low in this largely unexploited pike population.

Opinicon Lake - Twelve fish species were captured in index trapnets at Opinicon Lake: (in descending order of abundance) bluegill, black crappie, pumpkinseed, brown bullhead, largemouth bass, northern pike, yellow bullhead, rock bass, white sucker, smallmouth bass, yellow perch, and American eel. The overall Shannon diversity index was 2.35.
Alewife were the sixth most abundant species in index gillnets and were the only species captured in index gillnets that were absent from the trapnet catch.
Northern pike, smallmouth bass, and largemouth bass populations all exhibited high total mortality in response to heavy sport fishing pressure. Growth for smallmouth and largemouth bass populations appears good, mean fork length equaling the 30-cm minimum length limit.

Sydenham Lake - Twelve fish species were captured in trapnets at Sydenham Lake: (in descending order of abundance) bluegill, brown bullhead, black crappie, pumpkinseed, rock bass,

largemouth bass, yellow perch, northern pike, smallmouth bass, yellow bullhead, golden shiner, and white sucker. The overall Shannon diversity index was 2.23.

Lake herring, absent from the trapnet catch, was the most abundant species captured in index gillnets.

Age structure data indicates a high total mortality rate for largemouth bass.

Upper Rideau Lake - Seventeen fish species were captured in trapnets in Upper Rideau Lake: (in descending order of abundance) pumpkinseed, bluegill, yellow perch, rock bass, brown bullhead, smallmouth bass, black crappie, largemouth bass, northern pike, alewife, white sucker, walleye, yellow bullhead, golden shiner, shorthead redhorse, American eel, and burbot. The overall Shannon diversity index was 2.78.

Alewife was by far the most abundant species in index gillnets, outnumbering yellow perch, the second most abundant species, 2:1. Larval alewife also dominated index larval tows at all sampling locations and depths, accounting for 79.1% of the catch.

Age structure data indicates a high mortality rate for northern pike, largemouth bass, yellow perch, and walleye.

The mean age of walleye captured in the trapnets was 11.9 years; mean fork length, 62.0 cm, and mean weight, 3222 g. Although, adult walleye were observed spawning at the Westport dam, the entire area was covered with heavy algae growth, conditions unfavourable for successful incubation. No larval walleye were captured in larval tows. Plankton sampling indicated the presence of suitable food items for larval walleye.

1. INTRODUCTION

During 1982, the Rideau Lakes Fisheries Assessment Unit (RLFAU) initiated several long-term programs to monitor the fish communities and populations of five warmwater type lakes, ie. Long, Mica, Opinicon, Sydenham, and Upper Rideau Lakes (MacLean and Smith 1981). The program was intended to provide both qualitative and quantitative information for trend-through-time analysis.

The overall assessment program included:

1) index trapnetting to monitor the inshore (littoral) populations;
2) index gillnetting to monitor the offshore (benthic) populations;
3) a qualitative assessment of walleye spawning on Upper Rideau Lake; and
4) larval fish index netting on Upper Rideau Lake.

Data collected during these activities were used to determine:

1) species composition and diversity;
2) relative abundance;
3) distributions of age, fork length (FL), and weight;
4) mean fork length-at-age;
5) instantaneous growth rate;
6) Walford and von Bertalanffy growth parameters;
7) annual mortality rate;
8) occurence of parasites and disease; and
9) walleye spawning habits.

The purpose of this report is to summarize the community and population parameters listed above. While many species are considered, our report deals largely with northern pike, smallmouth bass, largemouth bass, yellow perch and walleye.

As this report provides a baseline for future trend-through-time analysis, we have purposely chosen not to compare parameters between lakes and to limit preliminary interpretations.

[1] Common names of fishes used throughout this report conform to Bailey et al (1970).

2. The Study Area

The five type lakes included in this study are all situated within or directly adjacent to the Rideau Corridor (Figure 2.1) in Divisions 9 and 10 of the Ontario Fishery Regulations (Ontario Ministry of Natural Resources (MNR) 1982).

MacLean and Hooper (1981) examined the physical, chemical, and biological characteristics of each lake in detail. Table 2.1 presents a revised summary of this information.

Long, Sydenham, and Upper Rideau Lakes exhibit a well defined thermocline with low hypolimnetic oxygen concentrations during the summer months; however, Mica and Opinicon Lakes do not thermally stratify. Smith and MacLean (1985) reported that Long Lake is oligotrophic while the other four waters are mesotrophic.

Table 2.1 Characteristics of the five study lakes.

Lake	Lake Community	Area	Mean Depth	TDS	T/O_2	MEI	Yield	Stresses Fishing	Stresses EAWPI
Long	0604	85.0	5.0	116.5	SLO	23.3	5.62	010	10000
Mica	0404	23.9	1.4	140.5	NST	100.4	10.78	010	00000
Opinicon	0604	786.7	2.5	122.0	NST	48.8	7.81	031	10111
Sydenham	0604	450.8	6.8	168.0	SLO	24.7	5.76	030	10010
Upper Rideau	0704	1362.8	8.1	150.0	SLO	18.5	5.07	031	10111

Definition of Columns -

Lake Community: First two columns = major community. 04 = northern pike; 06 = northern pike-smallmouth bass; 07 = northern pike-smallmouth bass-walleye.
Last two columns = minor community. 04 = largemouth bass.

Area = surface in hectares (ha).

Mean Depth = mean depth in metres (m).

TDS = total dissolved solids (mg/l) based on the lowest observed summer conductivity where TDS = 0.666 x Conductivity $_{25\,C}$ (Gale and Goodchild 1982).

T/O_2 = temperature/oxygen; ie. SLO = stratified, low oxygen; SHO = stratified, high oxygen; NST = not stratified.

MEI = metric morphoedaphic index (ppm/m).

Yield = Ryder's annual yield estimated for Northern Great Lakes - St. Lawrence Watershed (kg/ha/yr) (MNR 1982).

Stresses = Fishing: first column = no exploitation, second column = sport exploitation and third column = commercial exploitation; where 0 = none, 1 = low, 2 = medium, and 3 = high.
Other: presence = 1 or absence = 0, of E = eutrophication, A = acidification, W = water levels, P = physical alterations and I = introductions.
(Note: here introductions refer to exotic species. Various game fish have been successfully introduced to these waters in the past).

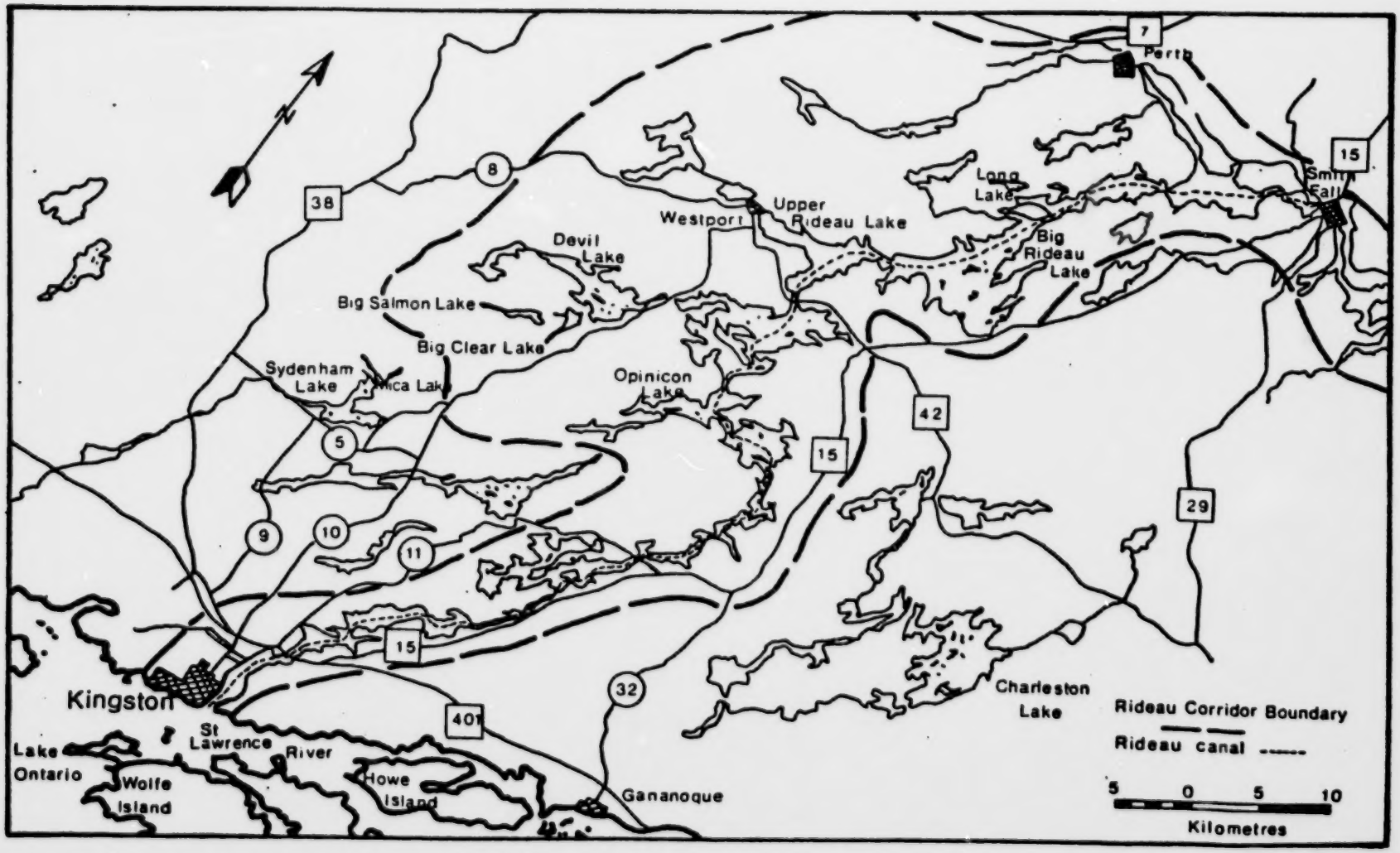

Figure 2.1 The Rideau Corridor and 10 RLFAU type lakes.

3. METHODS

3.1 FIELD PROCEDURES

3.1.1 Index trapnetting

The index trapnetting program was designed to provide baseline data on the relative abundance and diversity of fish in the littoral zone. Fish sampled during trapnetting also provided information on basic population parameters.

The trapnetting schedule allowed a 10-day sampling period on each of Upper Rideau (May 5-14), Opinicon (May 19-28), Long (June 2-11), and Sydenham Lakes (June 16-25); and a 5-day sample on Mica (June 28-July 1). Six trapnets were fished at each lake, except at Mica Lake, where three index sites were deemed adequate. Trapnet locations were not chosen on the basis of biological criteria alone. All lakes had a limited amount of littoral area where depths and bottom contours made trapnetting feasible, and netting locations were spaced as widely as possible within these areas.

Two sizes of trapnets were used; nets with a 1.8-m box (38-mm stretched mesh, 33.5-m lead), and nets with a 2.3-m box (44-m stretched mesh, 54.9-m lead). All nets were set overnight, and soaktimes were approximately 24 hours. The trapnetting schedule resulted in 54 lifts per lake (nine lifts X six locations), with the exception of Mica Lake which had 12 lifts (four lifts X three locations).

At every lift, major game species (northern pike, smallmouth bass, largemouth bass, yellow perch and walleye) were transferred to a holding cage for detailed sampling, while other species were simply counted and released.

All major game fish were measured for fork length (FL). Scales, total lengths (TL), and weights (g) were taken from a subsample of not more than 10 fish from each length class (see Section 3.2.3). Scales of soft-rayed fishes were taken from below the anterior edge of the dorsal fin, approximately two scales above the lateral line. Scales of spiny-rayed fishes were taken near the tip of the left pectoral fin, below the lateral line. Individ ual fish were also examined for fin-clips, external parasites and disease, and then released (MacLean and Smith 1982a).

Nets were partially cleaned of algae and debris after every lift, and were completely cleaned following every 10-day sampling period.

3.1.2 Index gillnetting

The index gillnetting program on the five study lakes was initially designed to provide baseline data on the relative abundance and diversity of warmwater species in offshore areas. In addition, gillnetted fish provided samples for food and feeding, contaminant and ageing studies (MacLean and Smith

1982b).

Gillnetting was conducted during the following periods on each of the lakes: Upper Rideau (July 13-16), Long (July 19-21), Opinicon (July 27-29), Mica (August 4-6), and Sydenham (August 9-11).

Netting locations were chosen where water was deep enough to have suitable temperature and oxygen levels for the target species. Temperature and dissolved oxygen were measured using a Hydrolab 8000™.

A standard gillnet set consisted of four net gangs. Each gang was 122-m long, 1.8-m deep, and contained eight randomly strung 15.2-m sections of stretched mesh ranging in size from 38 to 127 mm. Nets were set approximately parallel to the shoreline on the bottom, in depths ranging from 8 to 23 m. All sets were overnight, and soaktimes ranged from 9.1 to 22.3 hours (mean: 11.4; s.d. 3.6).

At every lift, the entire catch was removed from the nets and taken back to the RLFAU laboratory facilities for processing. All species were sampled for age, fork length, total length (TL), and weight. Fish were also examined for fin-clips, parasites, disease, sex, and stage of maturity (Kesteven 1960).

3.1.3 Walleye Spawning Assessment

The walleye spawning run was monitored on Upper Rideau Lake from April 9 to April 25, 1982. Three historical spawning sites were patrolled at night from shore using a light (Raine, personal communication). Water temperature, flow rate, and the number of walleye observed on the spawnbeds were recorded.

3.1.4 Index Larval Fish Trawling

The index larval fish trawling program was carried out on Upper Rideau Lake in order to assess the seasonal and spatial variation in the abundance of the young of all species.

The sampling period starting date of May 5, 1982 was chosen to coincide with the earliest possible emergence date of young walleye. Several 10-m vertical-haul zooplankton samples were also collected on this same date to investigate food availability.

Replicate larval tows were conducted weekly at 6 locations (4 shoreline locations, 2 offshore locations); until June 28, when the density of suspended algae precluded further sampling.

Offshore sites were sampled at the surface, and at midwater (approximately 4 m) using a 0.5-m diameter, 1:3 simple conical style net (500-u nitex mesh) and a 1.8-l volume cod end (502-u stainless steel mesh). A General Oceanics Model 2030 digital flowmeter was suspended in the net mouth to measure volume filtered.

The depth at shoreline locations ranged from 1 to 2 metres (mean 1.5 m). These locations were sampled using a sled tow apparatus (Figure 3.1, Chamberlain 1979) which allowed the 0.5-m

diameter net to travel approximately 0.75 m above the substrate, avoiding obstructions.

The boat speed for all tows was maintained between 0.7 and 1.0 m/sec using a General Oceanics Model 2035 Flowmeter Readout. Tow duration was 300s.

3.2 DATA ANALYSIS

3.2.1 A caution regarding index netting data interpretation

Aside from total removal, no fish sampling method is completely non-selective. Numerous investigations have shown that gillnets are often highly selective for certain size classes of fish, and in the absence of an accurate selectivity curve, the community and population parameters derived from gillnet data can be very biased (Hamley 1975; Pope et al 1975).

Selectivity of trapnets has received considerably less attention. However, trapnets too, can be both species and size-selective. Laarman and Ryckman (1982) and Latta (1959) have demonstrated that for many species (including yellow and brown bullhead, bluegill, pumpkinseed, rock bass, black crappie, yellow perch and walleye), larger fish are easier to catch than smaller fish. As such, Latta (1959) suggests that mortality estimates, calculated from the decrease in numbers of fish in successive age groups, be adjusted using mark-recapture data. Neither study was able to show significant size-selectivity for smallmouth or largemouth bass. On the other hand, Ricker (1975) states that bias in catch - curve survival estimates resulting from size - specific vulnerability seems unlikely to be large among the older fish in a sample.

Of even more concern to us, is the mounting evidence that even large samples of all types of index gear are of little value in assessing relative abundance due to variability in catches (Casselman, personal communication; Craig and Fletcher 1982; Hamley and Howley 1985; Vaughan and Van Winkle 1982). Hamley and Howley (1985), using 9 trapnet lifts per sampling design cell, found that their data only estimated geometric mean catches in Long Point Bay to within a factor of 2 of their true values (95% confidence). To estimate them to within 20-25% would have required about 100 lifts. Regarding possible future changes of abundance, it would take 3 years of observation to establish statistical significance of a decrease of arithmetic mean catches to half the levels observed during their study. Nevertheless, the authors feel that most sampling variability can be alleviated by standardization of gear, fishing methods, and sampling design.

As such, very little index gillnetting data is presented in this report, although it is available in RLFAU files. Our index trapnetting program is more appropriate for determining future community changes. If in future years, nets are fished at the same time of year in each lake, and environmental conditions have not changed greatly, then within-lake results should be suitable for trend-through-time analysis.

Other biases that could affect data interpretation are discussed separately below.

3.2.2 Community structure

Species composition (by number), diversity, and catch-per-unit-effort (CUE) data were all used to examine community structure of adult, juvenile (all lakes) and larval fishes (Upper Rideau Lake).

Species composition and diversity - Diversity of each community, based on all species captured in trapnets, was calculated using the Shannon index of general diversity (H), where :

$$H = -\text{Sum}\{(ni/N)\ \log2\ (ni/N)\},\ \text{and}$$

ni = number of individuals of species i;
N = total catch of all species
(Margalef 1968).

This index reflects both the degree of concentration of dominance in one or a few species (slope) and the number of species (richness). In general, steepness of slope tends to be inversely related to richness.

Percentage similarity analysis was used to determine the homogeneity between index trapnetting sites. The percent similarity between the catch at different netting sites was first calculated (based on the catch of the six most abundant species); then cluster analysis used to group locations. Haedrich (1975) proposed the use of these two indices as a measure of environmental quality. Hopefully, their use here will allow us to detect any fish community changes at a finer level.

Percent similarity (PS) was calculated as:

$$PS = 100\{1.0 - (0.5\ \text{Sum}\ (\text{Abs}(pia - pib)))\},$$

where pia = number of individuals in the ith species at location a divided by the total number of individuals at location a and pib = the same for location b.

In an attempt to detect differences in community composition between trapnet sites, Tukey-Krammer tests (Sokal and Rohlf 1981) were used. Percentage composition data were calculated on a daily basis and these data were transformed using $\sqrt{Y + 1/2}$ before analysis, where Y is the species' percentage (pia) described above. (This transformation is recommended by Steele and Torrie (1980) when some percentage values are <15% and zeros are present.) These tests quantify the significance of the differences between trapnet sites which are indicated by the percent similarity analysis.

Principal component analysis (PCA), based on percentages of the six most abundant species (pia above x 100), was used as an additional method to identify trapnet locations with similar community structure and to determine the relationships among the species defining that structure (Nichols 1977; Sprules 1977; Green 1979). Tonn et al (1983) have recently suggested that this

type of multivariate analysis will be useful in developing fisheries management strategies on a community basis. (Note: daily percentage composition was calculated for the Tukey-Krammer tests while PS and PCA tests did not consider daily variations in catch.)

Each component calculated in PCA describes a contrast in the relative abundance of the species sampled and the importance of that contrast in explaining the variation observed among the trapnet sites. The first component defines the greatest amount and each succeeding one a lesser aspect of the variation among the locations. The absolute values assigned to each species, within a component, provide a linear scale which is used to assess their contribution to the variation described by a particular component. The larger the value the greater the contribution. The signs, (+) or (-) of the values, describe the contrast between the species at each location.

Preliminary analysis of the percentage data indicated that the variance increased with mean values. To reduce the possibility of a single dominant species obscuring the community relationships among the net sites (Nichols 1977), a $\sqrt{Y+1/2}$ transformation was applied to the percentage data, where Y is the species' percentage (pia) described above. The variance - covariance matrix of the transformed percentages was used to derive the principal components.

Relative abundance - CUE values from trapnets, expressed as the number of fish caught per lift, were considered a measure of the relative abundance of littoral zone fishes, whereas gillnet CUEs measured the abundance of the offshore limnetic community. For the purpose of discussion, the species with the greatest CUE was considered to be numerically dominant. Other species with CUE values greater than 20% of the CUE of the dominant species were considered "moderately abundant". Species with CUEs less than 20% of that of the dominant species were deemed "relatively uncommon".

3.2.3 Population parameters

Age, fork length, and weight - Frequency distributions of scale age, FL, and weight have been plotted for all major sport species (northern pike, smallmouth bass, largemouth bass, yellow perch and walleye) from trapnet data.

Ageing - Scales were aged using a Realist Vantage microfiche reader at 33x magnification.

Subsampling for fork length and weight - All fish were measured for FL, but weight measurements, TL, and scale samples for ageing were taken from a subsample of not more than 10 fish per species in each FL class. The age and weight data was then expanded based on 1) the distributions of scale age and weight within each FL subsample, and 2) the total number of fish collected in each FL class. Mean age, FL and weight were then

estimated from this grouped data.

Growth - Estimating growth rates of fish is difficult because of the common occurrence of size selective natural and/or fishing mortality and sampling bias (Ricker 1969). As a means of overcoming some of the above difficulties, growth was assessed using three different methods, instantaneous growth rates, fork length-at-age, and the Walford and von Bertlanffy growth models.

The instantaneous growth rate of each population was calculated as the slope of the least squares regression line of the natural logarithm (ln) of the mean fork length-at-age against age using the appropriate exponential growth phase.

Only fish captured at, or close to a period of growth cessation were used for growth assessment (from spring-early summer trapnetting). As a result, an annulus was credited at the edge of the scale for ageing purposes and backcalculations were not necessary. Of the species sampled, growth standards have been determined only for northern pike and walleye. Growth indices, the fork length expressed as a percent of the growth standard, were used as a measure of the deviation in a data set from the growth standard established for and northern pike and walleye (MNR 1983).

Growth parameters estimated from Walford and von Bertalanffy growth models (Ricker 1975), in addition to (Galucci and Quinn 1979) were calculated for northern pike, smallmouth and largemouth bass, yellow perch, and walleye (MNR 1983).

Walford estimates are susceptible to numerous sources of error, including: 1) gear selectivity for larger size among fish, 2) underageing of older fish, 3) imprecise fork length-at-age estimates related to sample size, 4) non-representative sampling including only a narrow range of age groups with an increasing growth rate, and 5) sexual dimorphism. As a partial solution to number 3 above, it was decided, as a guideline for selecting which fork length-at-age estimates to include in the Walford analysis, that the confidence limit should be within 10% of the mean FL-at-age under consideration.

Walford and von Bertalanffy growth parameters have been reported only for those species in which the Walford slope was <1, and the square of the correlation coefficient was >0.90.

The estimates used to calculate w ($k \times L_{\infty}$), were determined based on a linear regression, and not from a non-linear procedure as recommended by Galucci and Quinn (1979). This was in part the result of the in house statistical procedures available; however, the high R^2 values (>0.90) indicate that a non-linear procedure would not have provided an improved fit of the data.

Mortality - Total annual mortality rates were calculated by constructing catch curves from age frequency data (Ricker 1975) derived from trapnet data.

Parasites and diseases - For major sport fish species caught in trapnets, the percentage occurrence of common external

parasites and disease was determined, ie. blackspot, Neascus sp.; red sore, Pseudomonas hydrophila, yellow grub, Clinostomum marginatum; and fish lice, Ergasilus or Salmincola sp..

Food and feeding - We had originally intended to compare the relative dietary importance of various food organisms between different length classes of target species using both numerical and volumetric methods (Hyslop 1980). However, small sample size precluded analysis following this design. The study was further hampered by the presence of large amounts of digested material and a high frequency of empty stomachs; presumably a function of high metabolic rate at this time of year. As such, only the percent occurrence of certain food items in target species' stomachs is reported.

Contaminant sampling (Hg) - These warmwater recreational fisheries had not been previously sampled for mercury contamination. An epoxial muscle fillet was collected from target species at each lake and forwarded to MOE, Rexdale for analysis (Ontario Ministry of the Environment (MOE) 1982). The concentrations of mercury found in these samples are reported in MNR/MOE (1985).

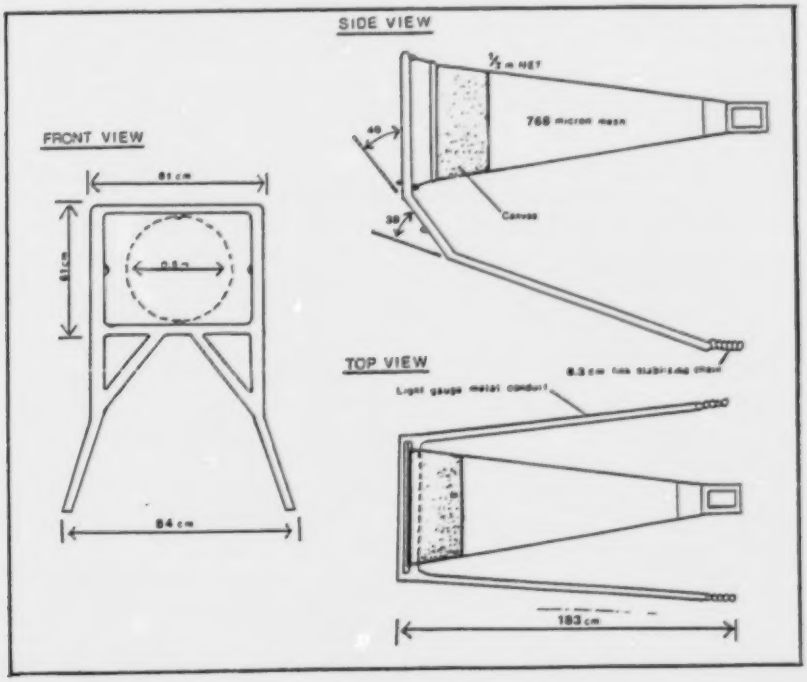

Figure 3.1 Sled tow used to sample larval fish over various bottom types in the littoral zone.

4. RESULTS AND DISCUSSION

4.1 LONG LAKE

4.1.1 Community Structure

Species composition and diversity - Bluegill (46.4%) comprised the greatest percentage of the trapnet catch, followed by pumpkinseed (21.4%), rock bass (14.6%), brown bullhead (8.4%), yellow perch (3.7%), and largemouth bass (3.5%). Northern pike, white sucker, golden shiner, yellow bullhead, and smallmouth bass each made up <1% of the catch. Most of the fish were caught at trapnet site 6 (Table 4.1, Fig. 4.1). The relative abundance of fishes in the littoral zone (as indicated by trapnet CUE) parallels the species composition data presented above (Table 4.2).

Rock bass was the most abundant species in the gillnet catch. Brown bullhead, pumpkinseed, bluegill, and yellow perch were moderately abundant. Northern pike, white sucker, yellow bullhead, smallmouth bass, and largemouth bass were present but relatively uncommon. All species caught in the trapnets were also caught in the gillnets with the exception of golden shiners (Table 4.2).

The overall Shannon diversity index was 2.18 and ranged from 1.43 (Site 7) to 2.33 (Site 5) for individual trapnet locations (Fig. 4.2).

With respect to species composition, the sites were divided into two groups. One, consisted of sites 2, 6, and 7, and the other of sites 1, 4, and 5. Within the above groups, sites 6 and 7, and sites 4 and 5, formed subgroups with a high percentage similarity relative to sites 1 and 2 (Fig. 4.2).

The major difference in species composition between the above groups was the higher proportional abundance of pumpkinseed but lower percentage of yellow perch and rock bass at sites 2, 6, and 7 compared to 1, 4, and 5 (Table 4.1, 4.3, Fig. 4.3). These differences accounted for 66% of the total variation among the trapnet locations (Table 4.4).

Within the group composed of sites 1, 4, and 5, the dissimilarity of site 1 was the result of its higher relative abundance of rock bass (38.4%) than sites 4 (21.7%) and 5 (16.5%) (Table 4.1, 4.3, Fig. 4.3).

Within the group composed of sites 2, 6, and 7, the dissimilarity of site 2 was the result of its higher proportional abundance of brown bullhead but lower percentage of bluegill than sites 6 and 7 (Table 4.1, 4.3, Fig. 4.3).

4.1.2 Population characteristics

Northern pike - The mean age of northern pike caught in the trapnets was 4.5 +/- 0.3 years, mean fork length

was 46.7 +/- 2.7 cm, and mean weight was 798 +/- 196 g. Ages ranged from 3-9 years with the 1978 (age 4) year class the most abundant (Fig. 4.4).

The growth rate of northern pike (ages 3-6) in Long Lake was below the provincial standard; the mean growth index for all ages was 93% (Table 4.5). Growth indices for ages 3-6 ranged from 79-87%, but were slightly higher for ages 7-9 (98-110%). The instantaneous growth rate was 0.149 +/- 0.029 based on ages 3-8 (Fig. 4.5). There was insufficient data for either Walford or von Bertalanffy analyses.

The total mortality rate for northern pike taken in the trapnets was 0.48 based on ages 4-9 (Table 4.7); well below the provincial standard of 0.65 (MNR 1983).

Blackspot was the only external parasite observed on northern pike during trapnetting (48% occurrence) (Table 4.8).

Northern pike in Long Lake appear to be primarily piscivorous. Of eight stomachs examined, 62.5% contained fish, 12.5% contained Decapoda, and 25.0% contained unidentifiable digested matter. One stomach was empty.

Smallmouth bass - The mean age of smallmouth bass captured in the trapnets was 6.2 +/- 0.4 years, mean fork length was 28.9 +/- 1.6 cm, and mean weight was 418 +/- 89 g. Ages ranged from 4-10 with the 1977 (age 5) year class the most abundant (Fig. 4.6).

The instantaneous growth rate was 0.121 +/- 0.025 based on ages 4-10 (Fig. 4.5). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Tables 4.5, 4.6).

The total mortality rate for smallmouth bass taken in the trapnets was 0.43 based on ages 5-10 (Table 4.8). Because a second peak in abundance occurred at age 7 (Fig. 4.6), the mortality rate was also calculated for ages 7-10 (0.57) (Table 4.7). Both of these rates are approaching the critical level (0.50) for smallmouth bass (MNR 1983).

Blackspot was the most common external parasite observed on smallmouth bass during trapnetting (57% occurrence) (Table 4.8).

Only one smallmouth bass stomach was examined. Seventy percent of stomach contents were fish and 30.0% unidentifiable digested material.

Largemouth bass - The mean age of largemouth bass captured in the trapnets was 6.5 +/- 0.2 years, mean fork length was 28.0 +/- 0.7 cm, and mean weight was 390 +/- 41 g. Ages ranged from 4-13 with the 1976 (age 6) year class the most abundant (Fig. 4.7).

The instantaneous growth rate was 0.102 +/- 0.016 based on ages 4-13 (Fig. 4.5).

The Walford (L_{∞}=37.9, k=0.264) and von Bertalanffy (L_{∞}=37.9, k=0.262, w=9.9) growth models predict a L_{∞} less than the maximum FL observed in the field (Tables 4.5, 4.6).

The total mortality rate for largemouth bass taken in the trapnets was 0.70 based on ages 6-9 (Table 4.7). Ninety-two percent of the sport fishery catch was in the age 6-9 interval.

The high mortality rate may be the population's response to the high 1982 angling effort levels (Schlesinger et al. 1984).

Blackspot was the most common external parasite observed on largemouth bass during trapnetting (12% occurrence) (Table 4.8).

The largemouth bass in Long Lake appear to be primarily piscivorous. Nine out of 10 largemouth bass stomachs examined contained food; of these, 50.0% contained fish remains, 10% contained plant matter, and 40% contained digested material.

Yellow perch - The mean age of the yellow perch caught in the trapnets was 7.1 +/- 0.1 years, mean fork length was 23.6 +/- 0.3 cm, and mean weight was 199 +/- 6 g. Ages ranged from 5-10 years with the 1975 (age 7) year class the most abundant (Fig. 4.8).

The instantaneous growth rate was 0.069 +/- 0.025 based on ages 5-9 (Fig. 4.5).

The Walford (L_{∞}=28.6, k=0.354) and von Bertalanffy (L_{∞}=28.6, k=0.373, w=10.7) growth parameters approach those expected in Ontario populations (Table 4.6). These L_{∞} values are similar to the maximum population lengths reported for Ontario by Sheri and Power (1969) (25.7 cm, age 8) and Harkness (1922) (27.9 cm, age 7).

The total mortality rate for yellow perch taken in the trapnets was 0.58 based on ages 7-10 (Table 4.7).

External parasites affected relatively few yellow perch in Long Lake. Yellow grub was the most common parasite observed, affecting 7% of the fish sampled (Table 4.8).

Twelve of 17 yellow perch stomachs examined contained food; 33.3% contained amphipods, 16.7% contained fish, 8.3% contained gastropods, and 41.7% contained unidentifiable digested material.

Table 4.1 Species composition and total catch at Long Lake during June 2-11, 1982 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							
	TN1	TN2	TN4	TN5	TN6	TN7	ALL SITES	TOTAL CATCH
Northern pike	0.5	1.2	0.8	1.0	0.8	0.5	0.9	64
White sucker			0.1	0.1			0.1	2
Golden shiner					0.1		0.1	1
Yellow bullhead	0.8	0.5	0.3				0.2	15
Brown bullhead	7.0	11.0	4.4	18.0	3.6	2.3	8.4	621
Rock bass	38.4	9.2	21.7	16.5	6.8	6.9	14.6	1075
Pumpkinseed	8.1	38.2	13.3	13.4	26.5	20.0	21.4	1579
Bluegill	33.5	33.0	48.8	40.3	56.4	67.9	46.4	3418
Smallmouth bass	0.3	0.8	0.6	1.1	0.8	0.5	0.8	57
Largemouth bass	2.7	6.0	3.1	2.3	3.9	1.8	3.5	261
Yellow perch	8.6	0.2	6.9	6.6	1.1	0.2	3.7	271
Total catch	729	1207	1088	1576	2328	436		7364
Percent catch	9.9	16.4	14.8	21.4	31.6	5.9	100.0	

Table 4.2 CUE for fishes caught at Long Lake during 1982 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear Type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Northern pike	1.2	9.0
White sucker	0.1	0.5
Golden shiner	0.1	
Yellow bullhead	0.3	0.5
Brown bullhead	11.5	41.5
Rock bass	19.9	60.5
Pumpkinseed	29.2	31.5
Bluegill	63.3	35.0
Smallmouth bass	1.1	0.5
Largemouth bass	4.8	4.5
Yellow perch	5.0	20.0

[1]total number of trapnet lifts = 54
[2]total number of gillnet lifts = 2

Table 4.3 Differences between trapnet sites based on mean daily percentage composition data for each of the six most abundant species caught in trapnets at Long Lake, June 2-11, 1982. Sites with at least one letter in common are not significantly different (tested using Tukey-Krammer analysis). The alphabetic order of the letters corresponds to the relative mean percentage of the species found at each site. For example: "a" represents those sites with the lowest mean, "b" the next highest, and so on.

Trapnet Site	Brown Bullhead	Rock Bass	Pumpkinseed	Bluegill	Largemouth Bass	Yellow Perch
1	b,c	d	a	a	a	b
2	c,d	a,b	d	a	b	a
4	a,b,c	c	a,b	a,b	a,b	b
5	d	b,c	a,b	a,b	a	b
6	a,b	a	c,d	b,c	a,b	a
7	a	a	b,c	c	a	a

Table 4.4 First two principal components for the six most abundant species caught in trapnets at Long Lake, June 2-11, 1982.

	Principal Component	
Species	1	2
Brown bullhead	0.2	-0.6
Rock bass	0.7	0.0
Pumpkinseed	-0.5	-0.4
Bluegill	-0.3	0.6
Largemouth bass	-0.1	-0.2
Yellow perch	0.5	0.1
Percent variance	65.9	25.0
Cumulative variance	65.9	90.9

Table 4.5 Mean fork length-at-age (cm), 95% confidence limits (CL), and growth indices (GI)[1] for fishes captured at Long Lake, 1982.
Values in parentheses are sample sizes.

Species		Age III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	Mean Growth Index
Northern pike	mean	39.0	41.7	50.0	54.6	68.6	80.7	79.2					
	CL	2.3	1.0	1.7	16.4	20.0	8.9	NA					
	GI	84	79	87	87	103	110	98					93
		(8)	(27)	(13)	(3)	(3)	(2)	(1)					
Smallmouth bass	mean		20.4	25.0	27.4	29.7	31.7	41.2	43.0				
	CL		3.8	1.2	1.7	1.5	3.6	1.3	NA				
			(3)	(10)	(6)	(9)	(4)	(2)	(1)				
Largemouth bass	mean		18.9	23.2	26.9	29.2	31.3	38.9	40.2	43.5	46.2	48.5	
	CL		1.2	0.5	0.7	1.1	1.8	7.1	15.7	2.8	2.2	1.5	
			(8)	(28)	(34)	(26)	(13)	(3)	(3)	(3)	(4)	(3)	
Yellow perch	mean			18.9	22.0	23.4	25.0	26.7	27.0				
	CL			0.4	0.8	0.7	0.7	1.2	3.1				
				(19)	(21)	(22)	(17)	(11)	(3)				

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for northern pike (MNR (1983).

Table 4.6 Walford and von Bertalanffy growth parameters for target species caught at Long Lake during index trapnetting June 2-11, 1982.
Blank spaces indicate data which did not fit the von Bertalanffy model.
NC denotes "not calculated".

Species	Ages	Walford L_{∞}(cm)	K	R^2	von Bertalanffy L_{∞}(cm)	K	t_o	W[1]	R^2
Northern pike				NC					
Smallmouth bass	4 - 9	132.2	0.037	0.84					
Largemouth bass	4 - 8	37.9	0.264	0.99	37.9	0.262	1.365	9.9	0.99
Yellow perch	5 - 10	28.6	0.354	0.95	28.6	0.373	2.256	10.7	0.98

[1] W = K x L_{∞} (Gallucci and Quinn 1979), based on a linear regression of Ln(L_{∞}-Lt) against age.

Table 4.7 Total mortality rates for target species captured at Long Lake during index trapnetting June 2-11, 1982.

Species	Mortality Rate	Confidence Interval	Ages
Northern pike	0.48	0.31 - 0.60	4 - 9
Smallmouth bass	0.43	0.25 - 0.56	5 - 10
	0.57	0.38 - 0.70	7 - 10
Largemouth bass	0.70	0.23 - 0.88	6 - 9
Yellow perch	0.58	0.00 - 0.83	7 - 10

Table 4.8 The percent occurrence of visible external parasites for target species sampled during trapnetting at Long Lake, June 2-11, 1982.
Blank spaces denote that no parasites were observed.

		Parasite			
Species	No.	Blackspot	Gill Fluke	Yellow Grub	Fin Rot
Northern pike	58	48			
Smallmouth bass	44	57	2		
Largemouth bass	139	12	1		3
Yellow perch	95	4	2	7	

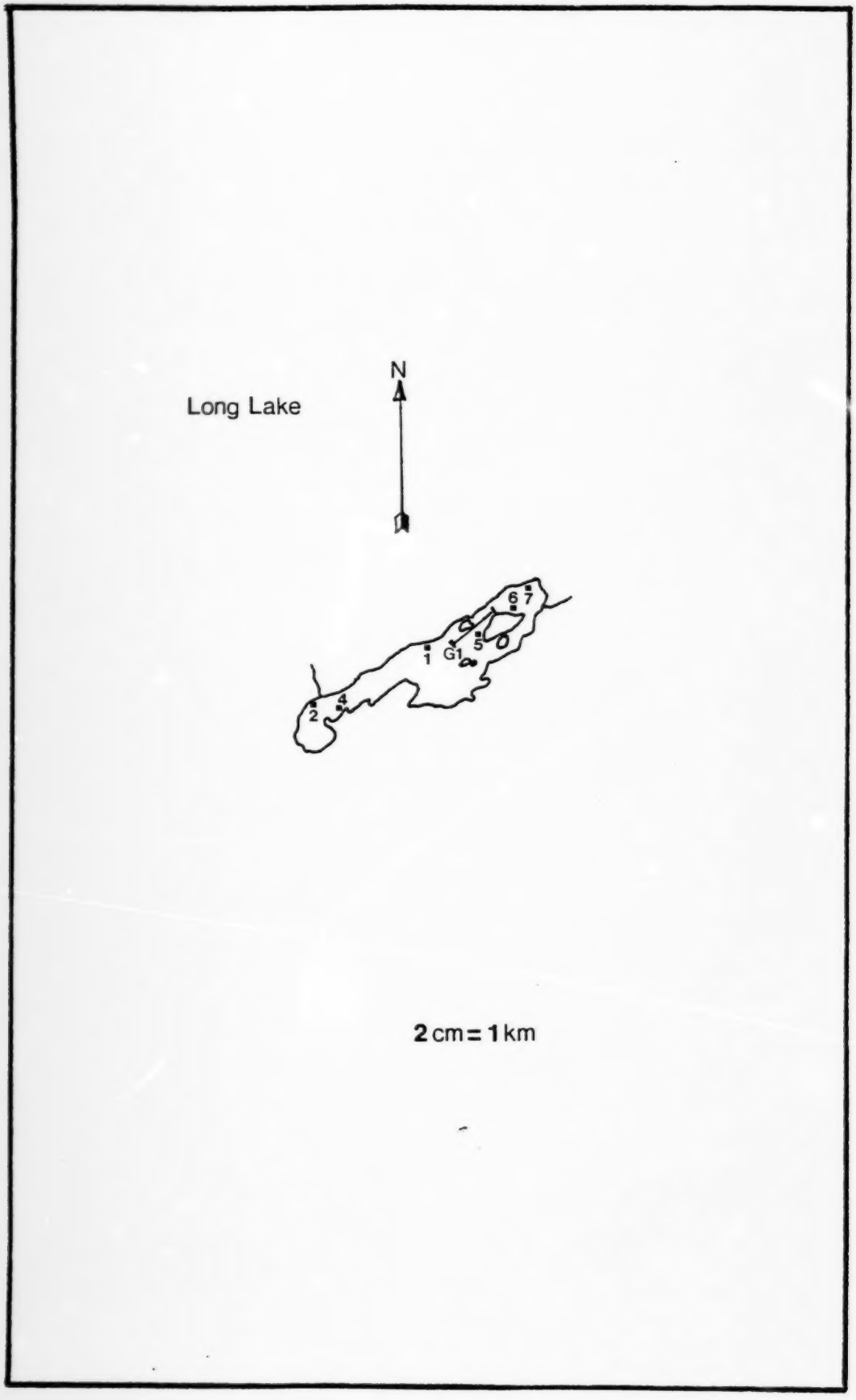

Figure 4.1 Index netting gear locations on Long Lake, 1982.
■ = trapnet location
G⊢⊣ = gillnet location

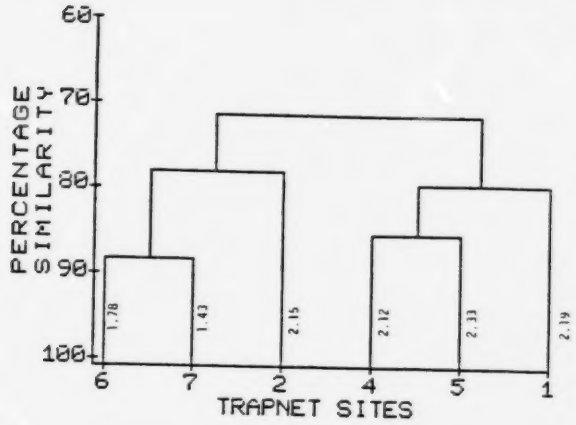

Figure 4.2 The percentage similarity between the trapnet sites on Long Lake, 1982. The number next to each cluster is the diversity index for the respective sites.

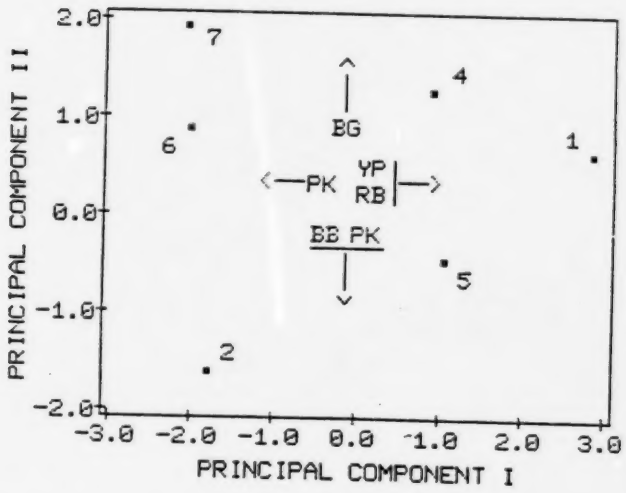

Figure 4.3 The major differences in species composition between the Long Lake trapnet sites, 1982. The arrows on each axis (principal component) indicate the direction of increasing proportional abundance of the designated species. PK, pumpkinseed; YP, yellow perch; BG, bluegill; RB, rock bass; BB, brown bullhead.

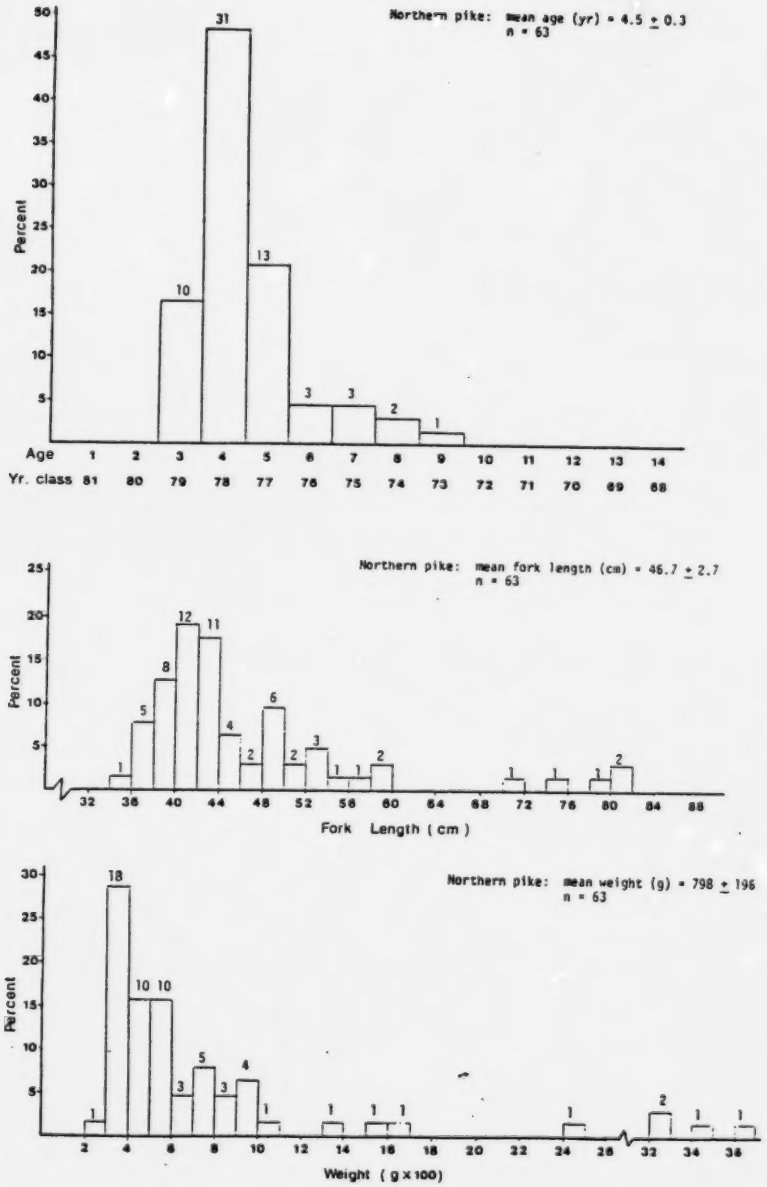
Northern pike: mean age (yr) = 4.5 ± 0.3
n = 63
Percent
Age
Yr. class
Northern pike: mean fork length (cm) = 46.7 ± 2.7
n = 63
Fork Length (cm)
Northern pike: mean weight (g) = 798 ± 196
n = 63
Weight (g x 100)

Figure 4.4 Age, fork length, and weight distributions of northern pike captured in trapnets at Long Lake, 1982. Numbers over each bar indicate actual count frequencies.

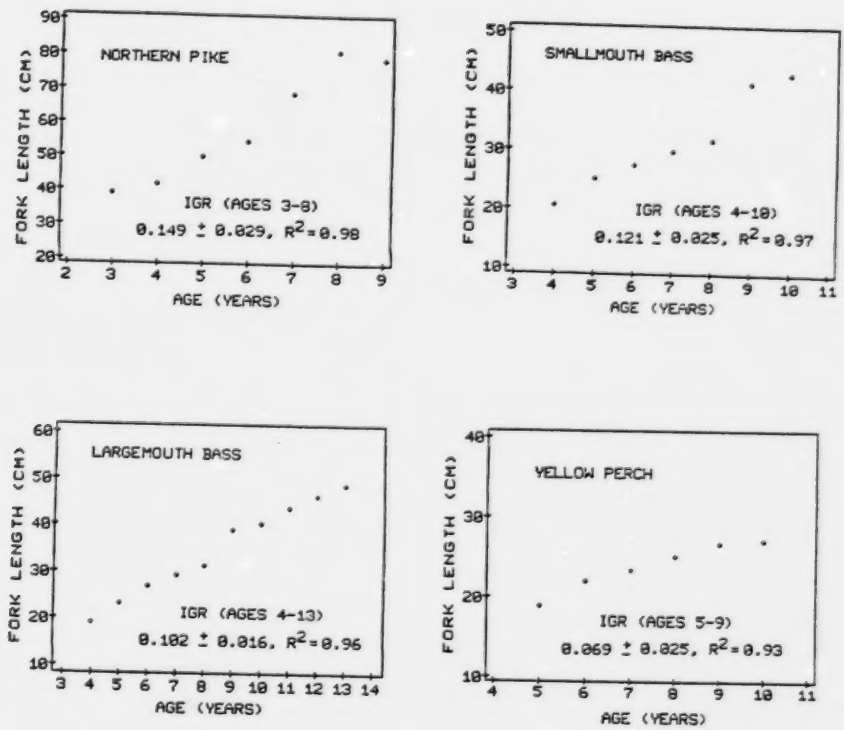

Figure 4.5 Absolute growth rate of northern pike, smallmouth bass, largemouth bass, and yellow perch sampled during index trapnetting at Long Lake, 1982. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

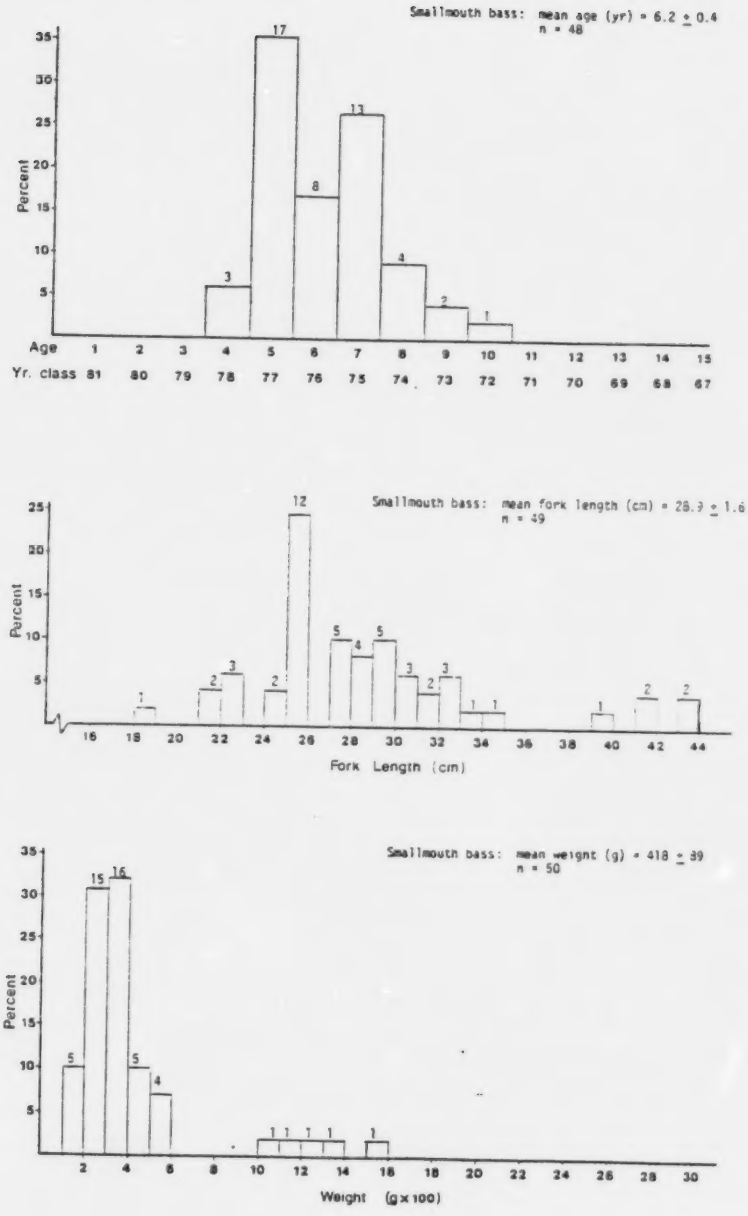

Figure 4.6 Age, fork length, and weight distributions of smallmouth bass captured in trapnets at Long Lake, 1982. Numbers over each bar indicate actual count frequencies.

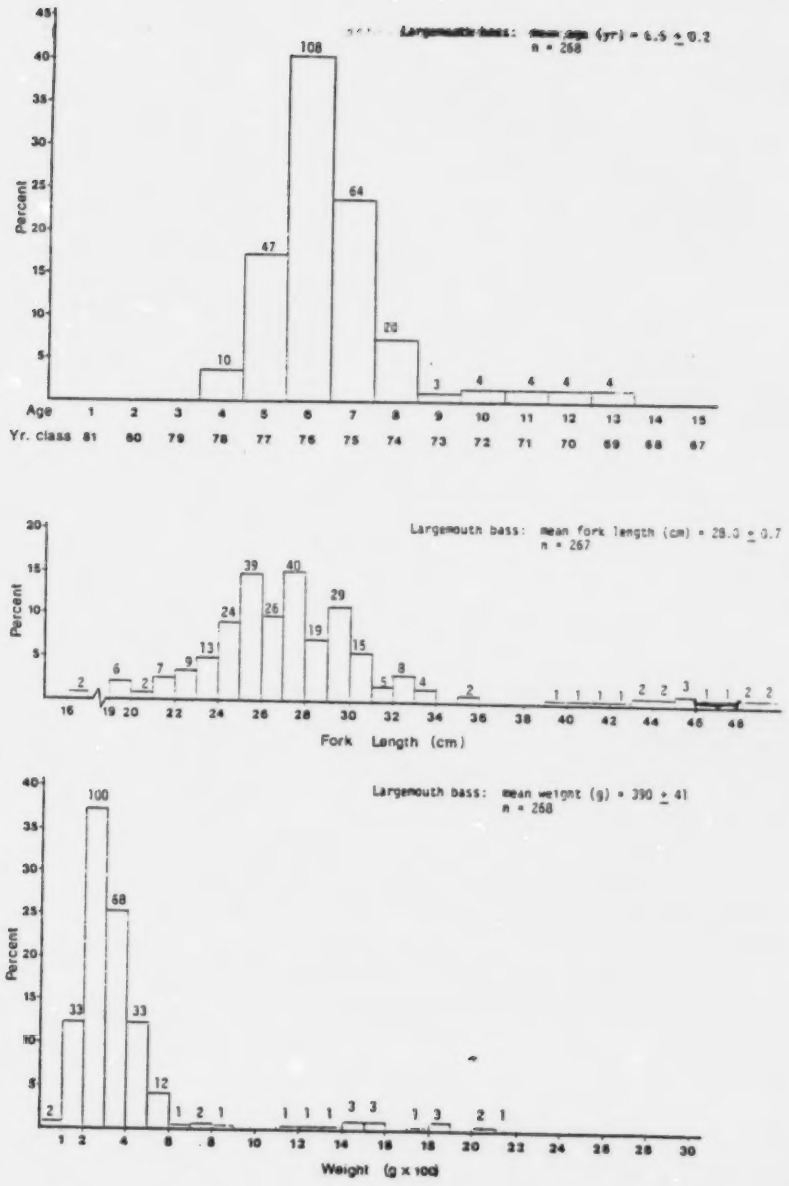
Largemouth bass: mean age (yr) = 6.5 ± 0.2
n = 268
Percent
Age
Yr. class
Largemouth bass: mean fork length (cm) = 28.0 ± 0.7
n = 267
Fork Length (cm)
Largemouth bass: mean weight (g) = 390 ± 41
n = 268
Weight (g x 100)

Figure 4.7 Age, fork length, and weight distributions of largemouth bass captured in trapnets at Long Lake, 1982. Numbers over each bar indicate actual count frequencies.

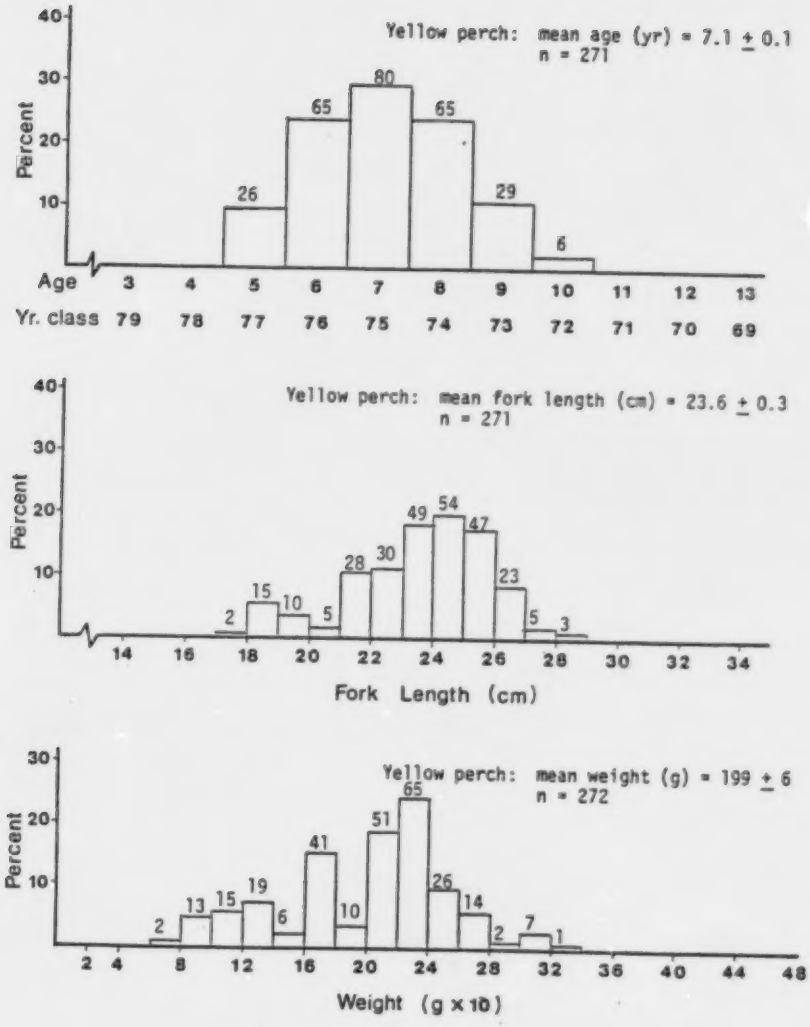
Yellow perch: mean age (yr) = 7.1 ± 0.1
n = 271
Percent
Age
Yr. class
Yellow perch: mean fork length (cm) = 23.6 ± 0.3
n = 271
Fork Length (cm)
Yellow perch: mean weight (g) = 199 ± 6
n = 272
Weight (g x 10)

Figure 4.8 Age, fork length, and weight distributions of yellow perch captured in trapnets at Long Lake, 1982. Numbers over each bar indicate actual count frequencies.

4.2 MICA LAKE

4.2.1 Community structure

Species composition - Brown bullhead (60.4%) comprised the greatest percentage of the catch, followed by pumpkinseed (18.9%), yellow bullhead (8.2%), bluegill (6.6%), rock bass (3.0%), and northern pike (2.3%). Largemouth bass and yellow perch each made up <1% of the trapnet catch. Most of the fish were caught at site 4 (Table 4.9, Fig. 4.9). The relative abundance of fishes in the littoral zone (as indicated by trapnet CUE) parallels the species composition data presented above (Table 4.10).

Seven species were captured during the index gillnetting program. All species caught in the trapnets were also captured in the gillnets with the exception of largemouth bass. Brown bullhead was the dominant species, while yellow bullhead, pumpkinseed, and yellow perch were moderately abundant. Northern pike, rock bass, and bluegill were present but relatively uncommon (Table 4.10).

The overall Shannon diversity index was 1.77 and ranged from 0.85 (site 4) to 2.19 (site 2) for individual trapnet locations (Fig. 4.10).

All of the sites had a relatively low percentage similarity (<55%) with respect to the other locations (Fig. 4.10). The distinctive composition of site 4 was the result of the absence of bluegill and the higher percentage of brown bullhead (85.1%) found there compared to the other two sites (>13% and <46% for these species respectively). The dissimilarity of trapnet 2 was a result of a higher proportion of pumpkinseed (41.3%) caught there as opposed to sites 4 and 7 (<6%). Site 7 differed in having a higher relative abundance of bluegill (28.6%) and northern pike (14.3%) than the remaining trapnets (<14% and <3% respectively for these species) (Table 4.9, 4.11, Fig. 4.11). The differences described above accounted for 100% of the variation among the trapnet sites (Table 4.12).

4.1.2 Population Characteristics

Northern pike - Northern pike was the only target species captured in sufficient numbers to allow a reasonable assessment of population characteristics. The mean age of northern pike caught in the trapnets was 4.8 +/- 0.7 years, mean fork length was 52.9 +/- 4.3 cm, and mean weight was 981 +/- 196 g. Ages ranged from 3-7 years and no single year class was dominant (Fig. 4.12).

The growth rate of the northern pike in Mica lake is slightly lower than expected for Ontario populations. The growth index for all ages was 93% (Table 4.13). The Walford line also yielded an L_{∞} (73.5 cm) markedly below the provincial standard of 98.3 cm (MNR 1983). The instantaneous growth rate was 0.107 +/- 0.046 based on ages 3-7 (Fig. 4.13).

The total mortality rate for northern pike caught in the

trapnets was 0.29, based on ages 5-7 (Table 4.14) and is well below the provincial critical limit of 0.60 (MNR 1983).

Blackspot was the most common external parasite observed on northern pike during trapnetting at Mica Lake (38% occurrence) (Table 4.15).

Table 4.9 Species composition and total catch at Mica Lake during June 28-July 2, 1982 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition				
	TN2	TN4	TN7	ALL SITES	TOTAL CATCH
Northern pike	2.3	1.3	14.3	2.3	16
Yellow bullhead	10.2	7.6		8.2	57
Brown bullhead	25.4	85.1	45.7	60.4	419
Rock bass	6.4	0.8	2.9	3.0	21
Pumpkinseed	41.3	5.1	5.7	18.9	131
Bluegill	13.6		28.6	6.6	46
Largemouth bass	0.8	0.3		0.4	3
Yellow perch			2.9	0.1	1
Total catch	264	395	35		694
Percent catch	38.0	56.9	5.0	100.0	

Table 4.10 CUE for fishes caught at Mica Lake during 1982 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear Type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Northern pike	1.3	1.0
Yellow bullhead	4.8	6.5
Brown bullhead	34.9	15.0
Rock bass	1.8	2.8
Pumpkinseed	10.9	6.5
Bluegill	3.8	2.0
Largemouth bass	0.3	
Yellow perch	0.1	4.0

[1]total number of trapnet lifts = 12
[2]total number of gillnet lifts = 2

Table 4.11 Differences between trapnet sites based on mean daily percentage composition data for each of the six most abundant species caught in trapnets at Mica Lake, June 28-July 2, 1982. Sites with at least one letter in common are not significantly different (tested using Tukey-Kramer analysis). The alphabetic order of the letters corresponds to the relative mean percentage of the species found at each site. For example: "a" represents those sites with the lowest mean, "b" the next highest, and so on.

Trapnet Site	Northern Pike	Yellow Bullhead	Brown Bullhead	Rock Bass	Pumpkinseed	Bluegill
2	a	b	a	a	b	a,b
4	a	b	a	a	a,b	a
7	b	a	a	a	a	b

Table 4.12 First two principal components for the six most abundant species caught in trapnets at Mica Lake, June 2-11, 1982.

	Principal Component	
Species	1	2
Northern pike	0.1	-0.4
Yellow bullhead	-0.0	0.5
Brown bullhead	-0.6	-0.1
Rock bass	0.2	0.1
Pumpkinseed	0.5	0.6
Bluegill	0.6	-0.5
Percent variance	59.3	40.7
Cumulative variance	59.3	100.0

Table 4.13 Mean fork length-at-age (cm), 95% confidence limits (CL), growth indices (GI)[1] and sample size (n) for fishes captured at Mica Lake, 1982.

Species		Age III	IV	V	VI	VII	Mean Growth Index
Northern pike	mean	40.3	50.6	53.6	57.7	64.5	
	CL	9.2	5.4	4.4	6.7	6.4	
	GI	87	96	93	92	97	93
	n	3	4	4	3	2	

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for northern pike (MNR (1983).

Table 4.14 Total mortality rates for target species captured at Mica Lake during index trapnetting June 28-July 2, 1982.

Species	Mortality Rate	Confidence Interval	Ages
Northern pike	0.29	0.00 - 0.54	4 - 7

Table 4.15 The percent occurrence of visible external parasites for target species sampled during trapnetting at Mica Lake, June 28-July 2, 1982.
Blank spaces denote that no parasites were observed.

Species	No.	Parasite Blackspot	Red Sore	Fin Rot
Northern pike	16	38		
Largemouth bass	3	33	67	33
Yellow perch	1	100		

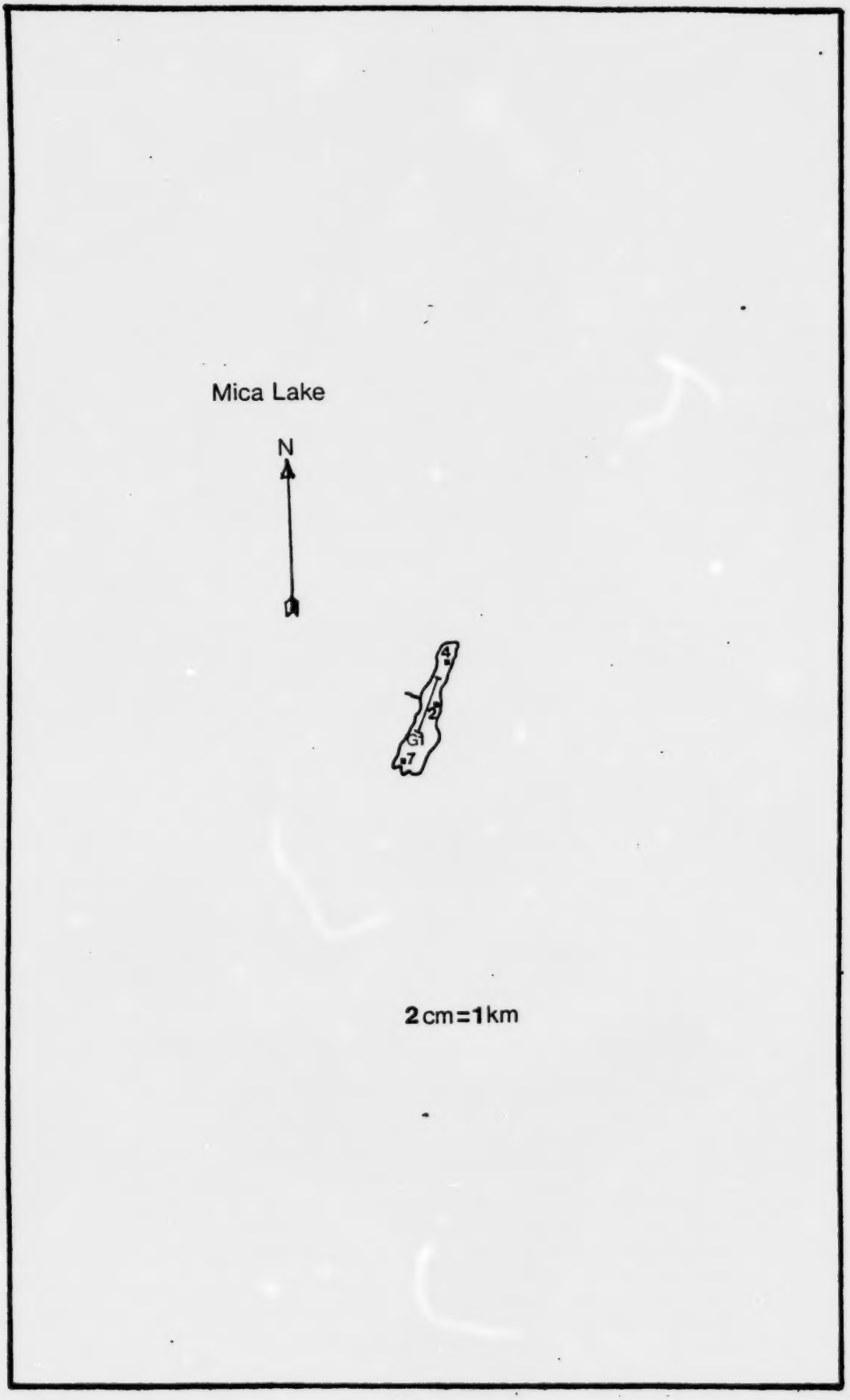

Figure 4.9 Index netting gear locations on Mica Lake, 1982.
■ = trapnet location
G⊢⊣ = gillnet location

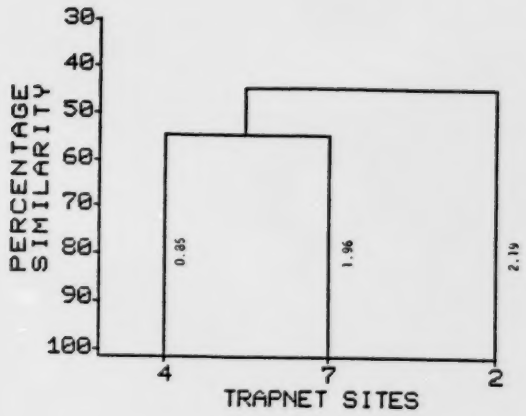

Figure 4.10 The percentage similarity between the trapnet sites on Mica Lake, 1982. The number next to each cluster is diversity index for the respective sites.

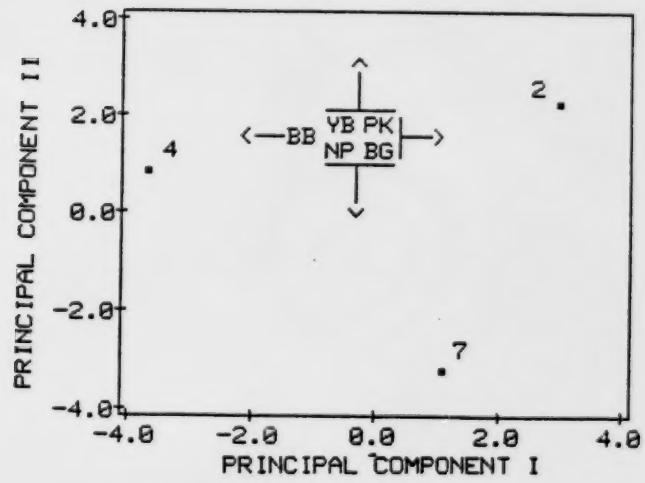

Figure 4.11 The major differences in species composition between the Mica Lake trapnet sites, 1982. The arrows on each axis (principal component) indicate the direction of increasing proportional abundance of the designated species. BB, brown bullhead; YB, yellow bullhead; NP, northern pike; BG, bluegill; PK, pumpkinseed.

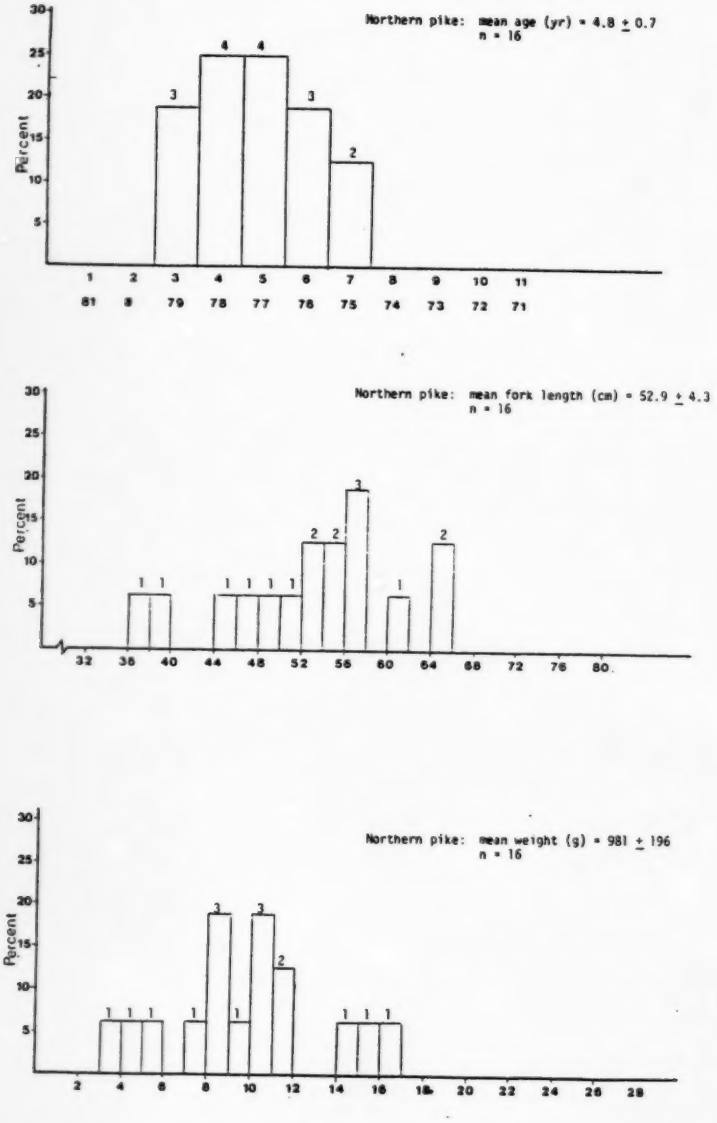

Figure 4.12 Age, fork length, and weight distributions of northern pike captured in trapnets at Mica Lake, 1982. Numbers over each bar indicate actual count frequencies.

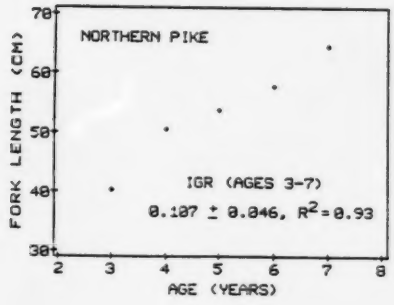

Figure 4.13 Absolute growth rate of northern pike, sampled during index trapnetting at Mica Lake, 1982. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown.

4.3 OPINICON LAKE

4.3.1 Community Structure

Species composition and diversity - Bluegill (37.5%) comprised the greatest percentage of the catch, followed by black crappie (22.4%), pumpkinseed (17.5%), brown bullhead (13.9%), largemouth bass (4.1%), northern pike (1.6%), and yellow bullhead (1.4%). White sucker, american eel, rock bass, smallmouth bass, and yellow perch each made up <1% of the catch. Most of the fish were caught at trapnet site 5 (Table 4.16, Fig. 4.14). The relative abundance of fishes in the littoral zone (as indicated by trapnet CUE) parallels the species composition data presented above (Table 4.17).

Twelve species were caught during the index gillnetting. Bluegill was the most abundant species in the gillnet catch, while yellow perch, brown bullhead, pumpkinseed, and black crappie were moderately abundant. Alewife, northern pike, white sucker, yellow bullhead, brown bullhead, rock bass, smallmouth bass, and largemouth bass were present but relatively uncommon (Table 4.17).

There was little difference between the gillnet and trapnet catches. With the exception of yellow perch, the dominant species were the same, and, but for the presence of alewife and absence of american eel in the gillnets, the species captured in each program were identical.

The overall Shannon diversity index was 2.35 and ranged from 1.74 (site 7) to 2.60 (site 2) for individual trapnet locations (Fig. 4.15).

With respect to species composition, sites 4 and 6 had the highest percentage similarity, sites 1 and 2 formed a second group of similar trapnet locations, and sites 5 and 7 were the most dissimilar (Fig. 4.15).

Most of the variation (73%) in species composition between the sites was the result of a contrast in the relative abundance of black crappie and brown bullhead caught at each trapnet location (Table 4.19). The proportion of black crappie ranged from a high at site 7 (50.9%) to a low at sites 4 (14.3%) and 6 (14.5%), while brown bullhead ranged from a low at site 7 (1.0%) to highs at sites 4 (19.8%) and 6 (19.6%). Sites 1, 2, and 5 were intermediate with respect to black crappie and brown bullhead abundance (Table 4.16, Fig. 4.16).

The dissimilarity of site 5 was the result of the high proportion (50.5%) of bluegill caught there compared to the other five locations (<36%) (Table 4.16, Table 4.18, Fig. 4.16)

4.2.2 Population characteristics

The mean age of northern pike caught in the trapnets was 4.8 +/- 0.2 years, mean fork length was 50.0 +/- 1.2 cm, and mean weight was 922 +/- 78 g. Ages ranged from 3-8 years with the 1977 (age 5) year class the most abundant (Fig. 4.17).

The growth rate of northern pike in Opinicon Lake was lower than the provincial standard. The growth index increased from 80% at age 3 to 98% at age 7 and was 90% for the most abundant age class (age 5). The growth index for all ages was 89% (Table 4.20). The instantaneous growth rate was 0.141 +/- 0.026 based on ages 3-7 (Fig. 4.18). Although significant, the Walford and von Bertalanffy growth models did not provide realistic growth estimates (Table 4.21).

The total mortality rate for northern pike taken in the trapnets was 0.76 (based on ages 5-8) (Table 4.22); exceeding the provincial standard (0.60) (MNR 1983).

External parasites affected a relatively low percentage of northern pike observed during trapnetting. Blackspot was the most common condition observed (6% occurrence) (Table 4.23).

Stomach content analysis of pike from Lake Opinicon showed that these fish are primarily piscivorous at this time of year. Five of eight northern pike stomachs examined contained food; 60.0% contained fish remains, and 40.0% contained unidentified digested matter.

Smallmouth bass - The mean age of smallmouth bass taken in the trapnets was 6.4 +/- 0.7 years, mean fork length was 30.5 +/- 2.8 cm, and mean weight was 523 +/- 135 g. Ages ranged from 5-9 years with the 1975 (age 5) year class the most abundant (Fig. 4.19).

The instantaneous growth rate was 0.107 +/- 0.054 based on ages 5-9 (Table 4.20, Fig. 4.18). There was insufficient FL-at-age data for either the Walford or von Bertalanffy growth models (Table 4.21).

The total mortality rate for smallmouth bass taken in the trapnets was 0.55 based on ages 7-9 (Table 4.22); slightly exceeding the provincial standard (0.50) (MNR 1983).

Blackspot was the only external parasitic condition observed on smallmouth bass during trapnetting (27% occurrence) (Table 4.26).

Although the contents of three smallmouth bass stomachs examined were largely digested, two stomachs contained fish remains, while Ephemeroptera were recognizable in the third.

Largemouth bass - The mean age of largemouth bass caught in the trapnets was 6.9 +/- 0.1 years, mean fork length was 30.0 +/- 0.4 cm, and mean weight was 477 +/- 21 g. Ages ranged from 4-11 years with the 1975 (age 7) year class the most abundant (Fig. 4.20).

The instantaneous growth rate was 0.109 +/- 0.028 based on ages 4-11 (Table 4.20, Fig. 4.18).

The Walford (L_{∞}=49.9, k=0.167) and von Bertalanffy (L_{∞}=49.9, k=0.175, w=8.7) growth parameters indicate a growth rate compareable to other Ontario populations (Table 4.21). The estimates of L_{∞} approach the average maximum population length (53.3 cm) reported for Ontario (MacKay 1963).

The total mortality rate for largemouth bass taken in the trapnets was 0.60 based on ages 7-11 (Table 4.22).

Blackspot was the most common parasitic condition observed and was found on 16% of the largemouth sampled in the trapnets (Table 4.23).

Yellow perch - The mean age of the yellow perch caught in the trapnets was 9.1 +/- 1.6 years, mean fork length was 24.0 +/- 2.9, and mean weight was 225 +/- 75 g. Ages ranged from 4-12 years with the 1974 and 1970 (ages 8 and 12 respectively) year classes the most abundant (Fig. 4.21).

The instantaneous growth rate, Walford, and von Bertalanffy growth parameters could not be calculated as a result of the variation in FLs-at-age (Table 4.21).

The total mortality rate for yellow perch taken in the trapnets was 0.50 based on ages 8-10 (Table 4.22).

Yellow grub was the most prevalent external parasitic condition observed and was found on 20% of the yellow perch examined (Table 4.23).

The yellow perch in Opinicon Lake apparently eat a wide variety of invertebrates. Only five of 10 yellow perch stomachs examined contained food; 40% contained Diptera, 20% Cladocera, 20% Copepoda, and 20% Hydrocarina.

Table 4.16 Species composition and total catch at Opinicon Lake during the May 19-28, 1982 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							
	TN1	TN2	TN4	TN5	TN6	TN7	ALL SITES	TOTAL CATCH
Northern pike	0.7	4.2	2.1	1.4	1.6	2.8	1.6	123
White sucker	0.1	3.3	0.1	0.2			0.3	23
Yellow bullhead	1.5	2.2	1.1	0.5	3.8	0.2	1.4	108
Brown bullhead	14.3	17.1	19.8	11.0	19.6	1.0	13.9	1054
American eel				<0.1			<0.1	1
Rock bass	0.3	0.9	1.9	0.3	2.6	0.6	0.9	71
Pumpkinseed	19.4	10.6	21.5	14.6	23.2	11.3	17.5	1324
Bluegill	27.8	29.3	35.8	50.5	28.0	31.9	37.5	2842
Smallmouth bass	0.1	0.2	0.2	0.4	0.1		0.2	16
Largemouth bass	5.7	5.1	2.9	2.6	6.7	1.2	4.1	309
Black crappie	29.8	26.8	14.3	18.4	14.5	50.9	22.4	1701
Yellow perch	0.4	0.2	0.1	0.1	0.1	0.2	0.2	12
Total catch	1678	451	893	2784	1273	505		7584
Percent catch	22.1	5.9	11.8	36.7	16.8	6.7	100.0	

Table 4.17 CUE for fishes caught at Opinicon Lake during 1982 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear Type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Alewife		27.5
Northern pike	2.3	12.5
White sucker	0.4	3.5
Yellow bullhead	2.0	3.5
Brown bullhead	19.5	90.5
American eel	<0.1	
Rock bass	1.3	2.0
Pumpkinseed	24.5	47.0
Bluegill	52.6	161.0
Smallmouth bass	0.3	1.5
Largemouth bass	5.7	1.5
Black crappie	31.5	42.0
Yellow perch	0.2	75.5

[1]total number of trapnet lifts = 54
[2]total number of gillnet lifts = 2

Table 4.18 Differences between trapnet sites based on mean daily percentage composition data for each of the six most abundant species caught in trapnets at Opinicon Lake, May 19-28, 1982. Sites with at least one letter in common are not significantly different (tested using Tukey-Kramer analysis). The alphabetic order of the letters corresponds to the relative mean percentage of the species found at each site. For example: "a" represents those sites with the lowest mean, "b" the next highest, and so on.

Trapnet Site	Northern Pike	Brown Bullhead	Pumpkinseed	Bluegill	Largemouth Bass	Black Crappie
1	a	b	a,b	a,b	b	a
2	b	b	a	a,b	b	a
4	a,b	b	a,b	a,b	a,b	a
5	a	b	a,b	b	a	a
6	a	b	b	a,b	b	a
7	a,b	a	a,b	a	a	b

Table 4.19 First two principal components for the six most abundant species caught in trapnets at Opinicon Lake, May 19-28 1982.

Species	Principal Component 1	Principal Component 2
Northern pike	0.1	0.1
Brown bullhead	-0.7	0.3
Pumpkinseed	-0.3	0.1
Bluegill	-0.0	-0.8
Largemouth bass	-0.2	0.4
Black crappie	0.7	0.4
Percent variance	73.3	16.4
Cumulative variance	73.3	89.7

Table 4.20 Mean fork length-at-age (cm), 95% confidence limits (CL), and growth indices (GI)[1] for fishes captured at Lake Opinicon, 1982.
Values in parentheses are sample sizes.

Species		Age III	IV	V	VI	VII	VIII	IX	X	XI	XII	Mean Growth Index
Northern pike	mean	36.9	44.8	51.6	58.7	65.4						
	CL	5.4	1.0	0.9	3.3	78.8						89
	GI	80	85	90	94	98						
		(3)	(39)	(48)	(19)	(2)						
Smallmouth bass	mean			25.6	27.2	34.2	36.7	37.6				
	CL			4.9	6.3	2.0	NA	NA				
				(4)	(3)	(5)	(1)	(1)				
Largemouth bass	mean		18.4	22.8	27.0	30.5	33.8	34.1	40.0	40.4		
	CL		4.6	0.8	0.6	0.9	1.1	2.1	9.5	5.2		
			(3)	(17)	(35)	(42)	(22)	(9)	(3)	(3)		
Yellow perch	mean		16.6				23.3	21.7	23.7		29.3	
	CL		NA				4.0	12.7	NA		1.5	
			(1)				(4)	(2)	(1)		(3)	

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983). Of the target species sampled, growth standards have been established only for northern pike (MNR (1983).

Table 4.21 Walford and von Bertalanffy growth parameters for target species caught at Opinicon Lake during index trapnetting May 19-28, 1982.
Blank spaces indicate data which did not fit the von Bertalanffy model.
NC denotes "not calculated".

Species	Ages	Walford Loo(cm)	K	R^2	von Bertalanffy Loo(cm)	K	t_o	W[1]	R^2
Northern pike	3 - 6	172.6	0.058	0.99	172.6	0.058	-1.176	10.0	0.99
Smallmouth bass					NC				
Largemouth bass	4 - 11	49.9	0.167	0.93	49.9	0.175	1.544	8.7	0.97
Yellow perch					NC				

[1] W = K x Loo (Gallucci and Quinn 1979), based on a linear regression of Ln(Loo-Lt) against age.

Table 4.22 Total mortality rates for target species captured at Opinicon Lake during index trapnetting May 19-28, 1982.

Species	Mortality Rate	Confidence Interval	Ages
Northern pike	0.76	0.39 - 0.90	5 - 8
Smallmouth bass	0.55	0.00 - 1.00	7 - 9
Largemouth bass	0.60	0.41 - 0.73	7 - 11
Yellow perch	0.50	0.50 - 0.50	8 - 10

Table 4.23 The percent occurrence of visible external parasites for target species sampled during trapnetting at Opinicon Lake, May 19-28, 1982.
Blank spaces denote that no parasites were observed.

		Parasite		
Species	No.	Blackspot	Red Sore	Yellow Grub
Northern pike	110	6	4	
Smallmouth bass	15	27		
Largemouth bass	151	16		1
Yellow perch	10	10		20

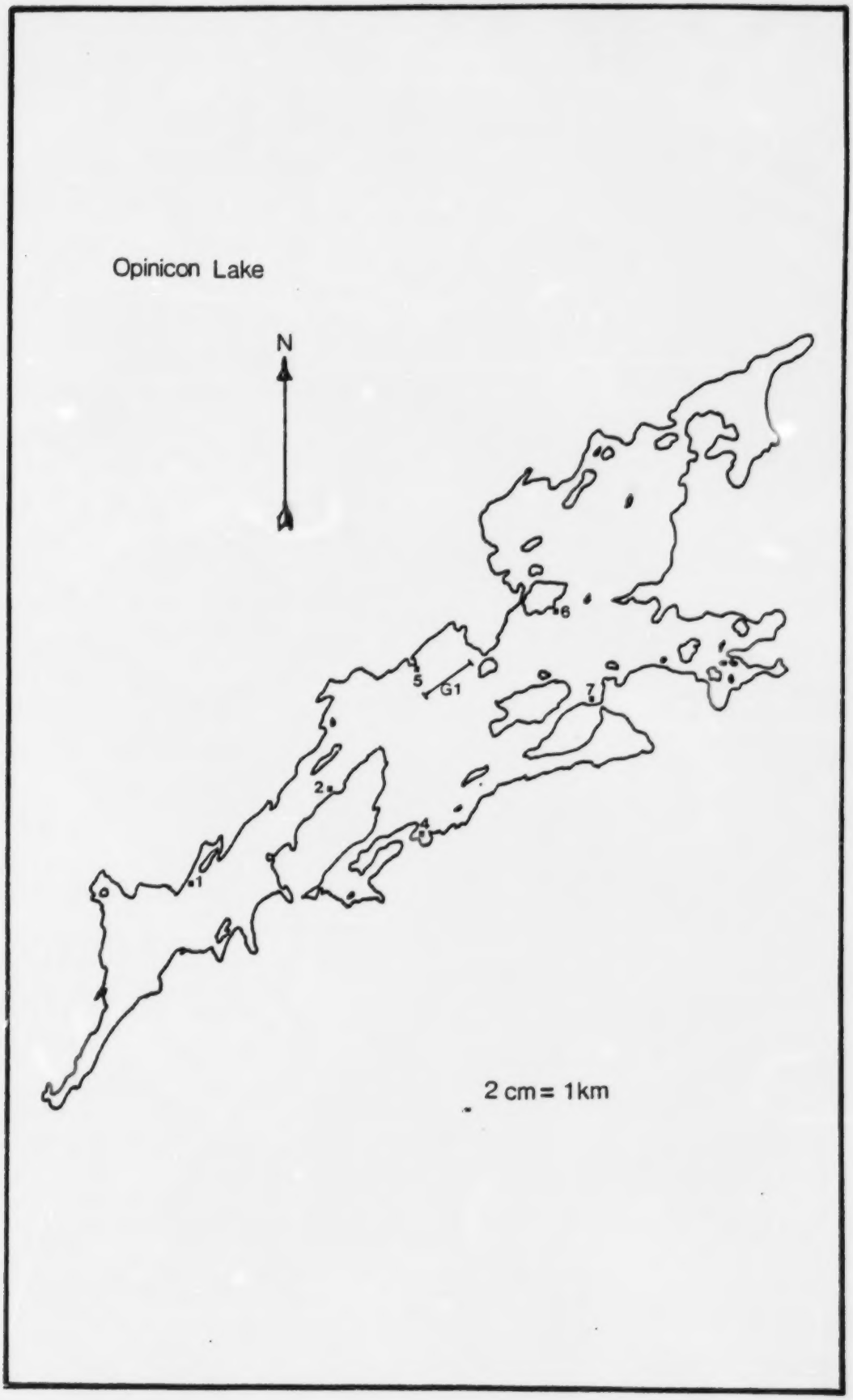

Figure 4.14 Index netting gear locations on Opinicon Lake, 1982.
■ = trapnet location
G⟷ = gillnet location

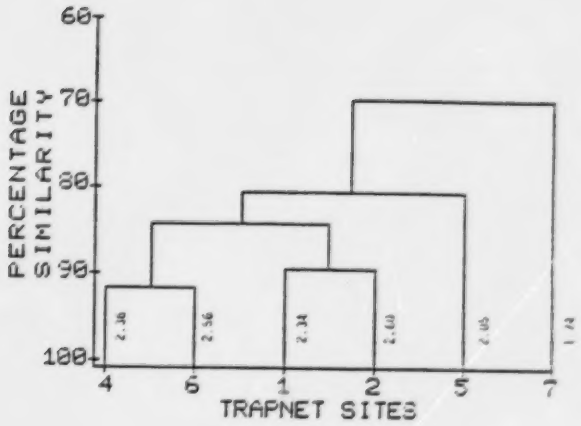

Figure 4.15 The percentage similarity between the trapnet sites on Opinicon Lake, 1982. The number next to each cluster is the diversity index for the respective sites.

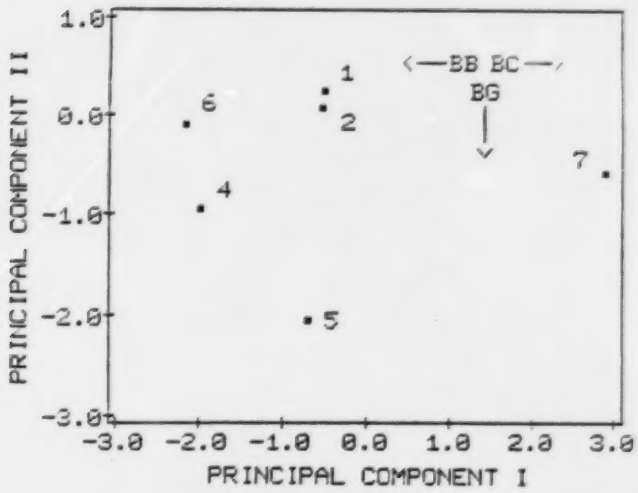

Figure 4.16 The major differences in species composition between the Opinicon Lake trapnet sites, 1982. The arrows on each axis (principal component) indicate the direction of increasing proportional abundance of the designated species. BB, brown bullhead; BC, black crappie; BG, bluegill.

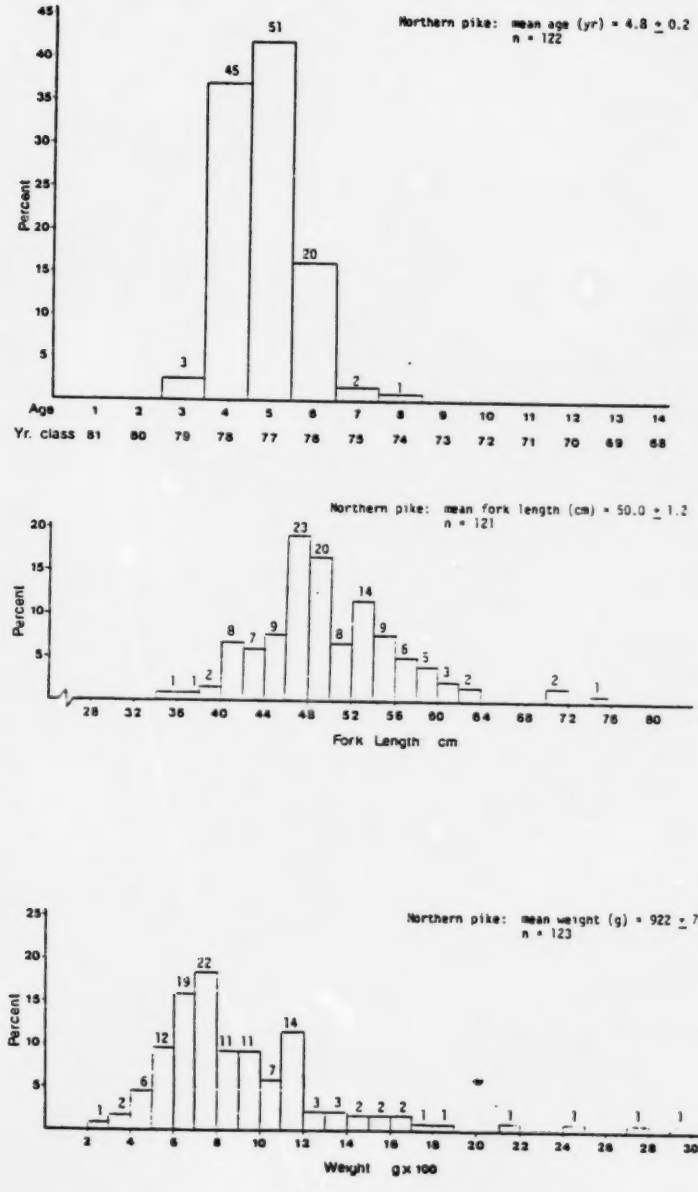
Northern pike: mean age (yr) = 4.8 ± 0.2
n = 122
Percent
Age
Yr. class
Northern pike: mean fork length (cm) = 50.0 ± 1.2
n = 121
Fork Length cm
Northern pike: mean weight (g) = 922 ± 78
n = 123
Weight g x 100

Figure 4.17 Age, fork length, and weight distributions of northern pike captured in trapnets at Opinicon Lake, 1982. Numbers over each bar indicate actual count frequencies.

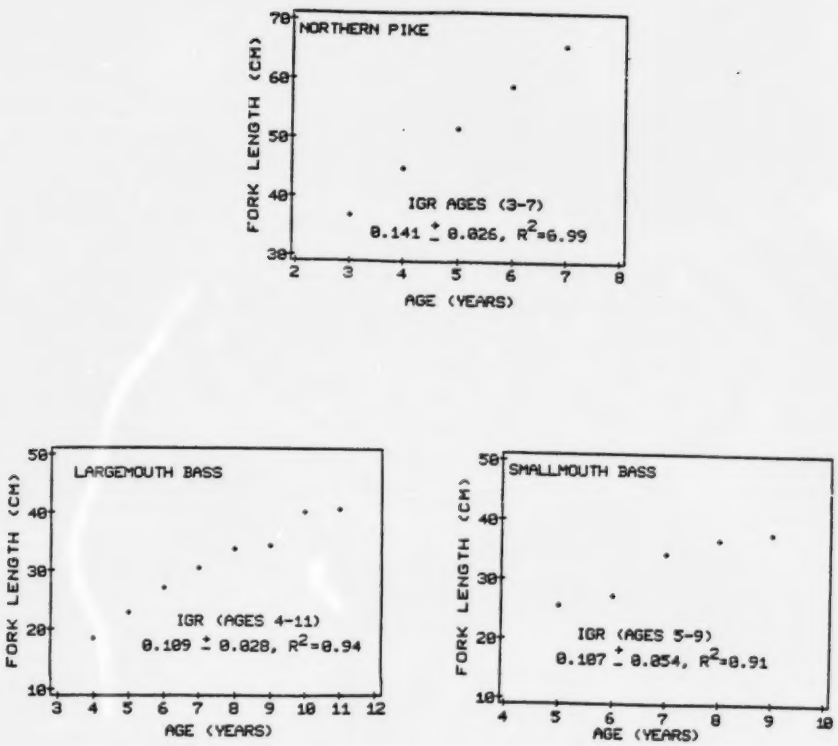

Figure 4.18 Absolute growth rate of northern pike, smallmouth bass, and largemouth bass, sampled during index trapnetting at Opinicon Lake, 1982. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

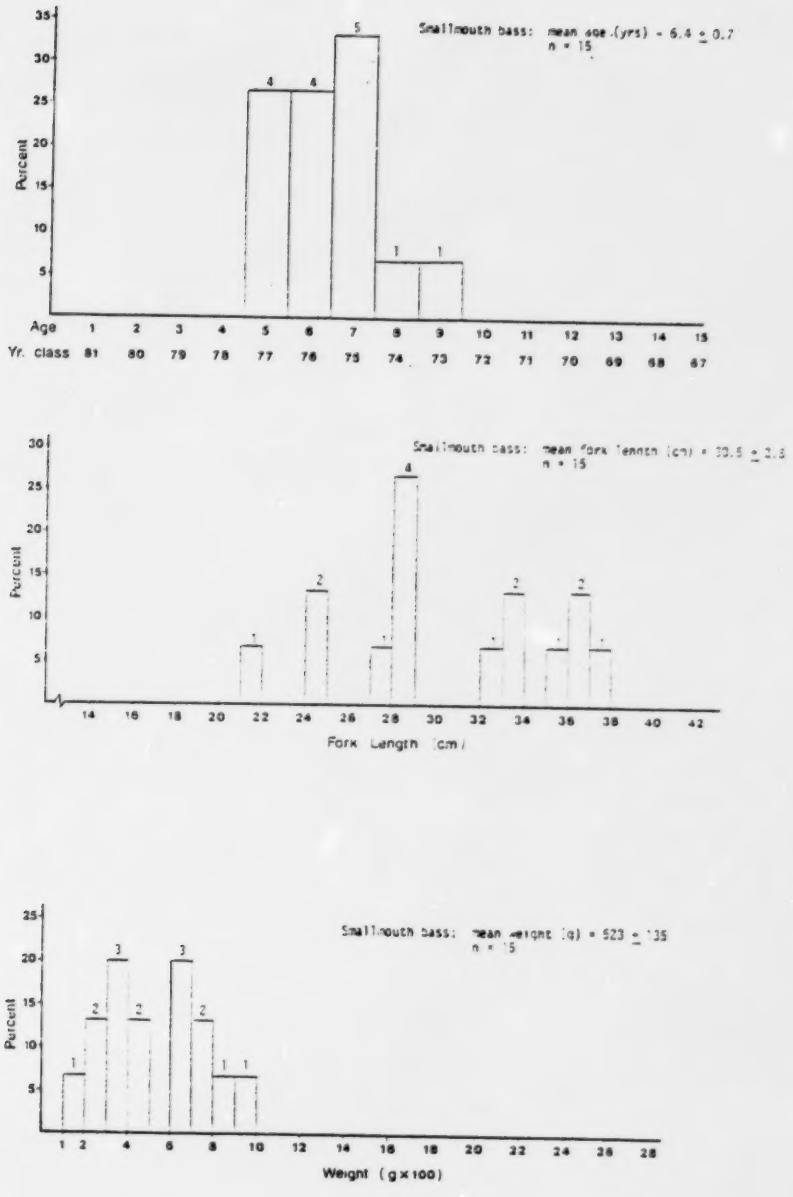
Smallmouth bass: mean age (yrs) = 6.4 ± 0.7
n = 15
Percent
Age
Yr. class
Smallmouth bass: mean fork length (cm) = 29.5 ± 2.8
n = 15
Fork Length (cm)
Smallmouth bass: mean weight (g) = 523 ± 135
n = 15
Weight (g x 100)

Figure 4.19 Age, fork length, and weight distributions of smallmouth bass captured in trapnets at Opinicon Lake, 1982. Numbers over each bar indicate actual count frequencies.

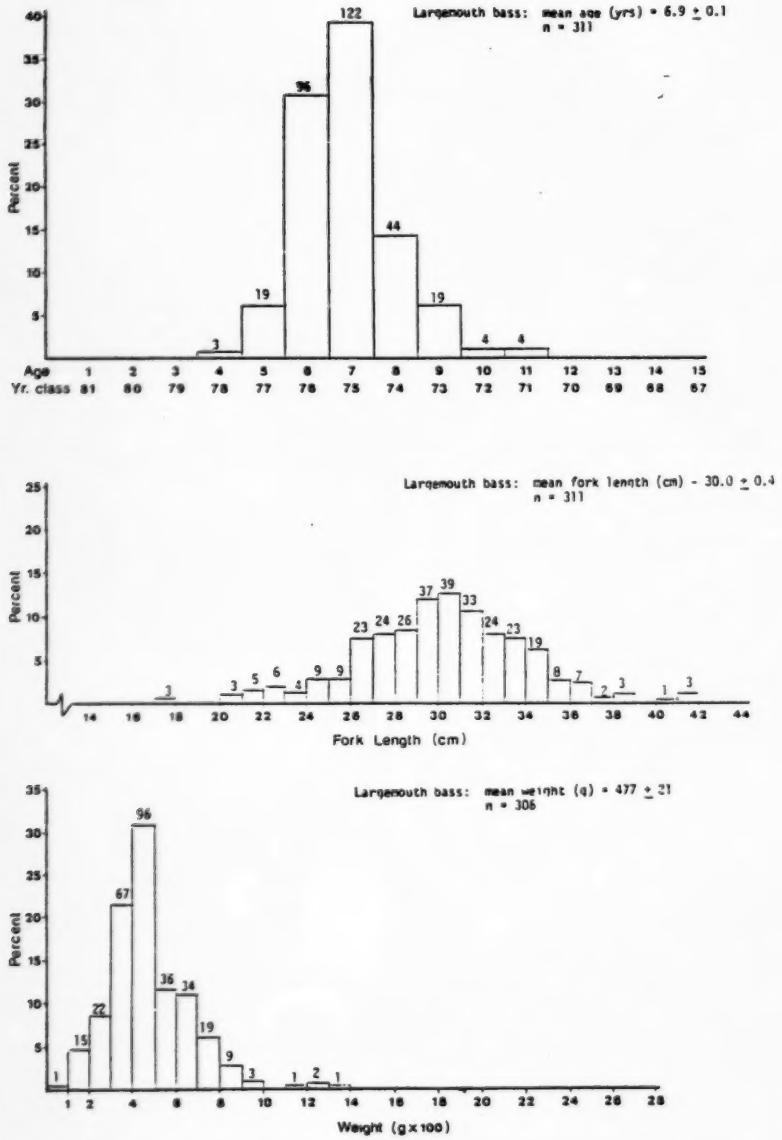
Largemouth bass: mean age (yrs) = 6.9 ± 0.1
n = 311
Percent
Age
Yr. class
Largemouth bass: mean fork length (cm) = 30.0 ± 0.4
n = 311
Fork Length (cm)
Largemouth bass: mean weight (g) = 477 ± 21
n = 306
Weight (g x 100)

Figure 4.20 Age, fork length, and weight distributions of largemouth bass captured in trapnets at Opinicon Lake, 1982. Numbers over each bar indicate actual count frequencies.

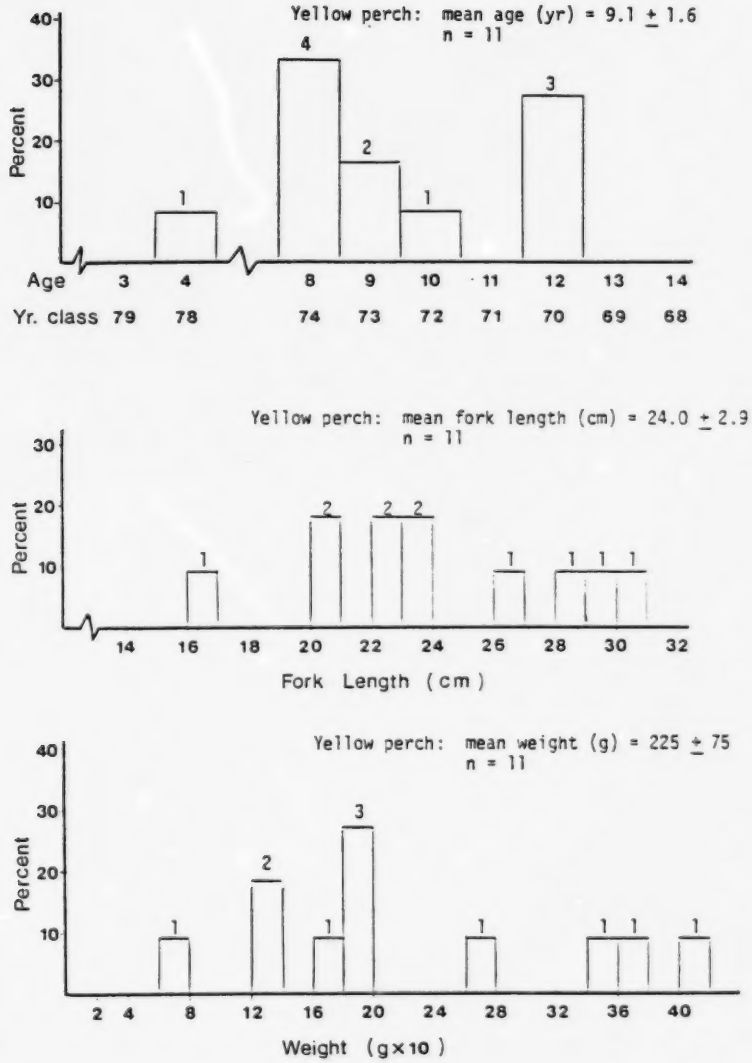
Yellow perch: mean age (yr) = 9.1 ± 1.6
n = 11
Percent
Age
Yr. class
Yellow perch: mean fork length (cm) = 24.0 ± 2.9
n = 11
Fork Length (cm)
Yellow perch: mean weight (g) = 225 ± 75
n = 11
Weight (g×10)

Figure 4.21 Age, fork length, and weight distributions of yellow perch captured in trapnets at Opinicon Lake, 1982. Numbers over each bar indicate actual count frequencies.

4.4 SYDENHAM LAKE

4.4.1 Community structure

Species composition - Bluegill (40.3%) comprised the greatest percentage of the catch, followed by brown bullhead (27.7%), black crappie (16.3%), pumpkinseed (7.9%), rock bass (3.4%), largemouth bass (1.3%), and yellow perch (1.2%). Northern pike, white sucker, golden shiner, yellow bullhead, and smallmouth bass each made up <1% of the catch. Most of the fish were caught at trapnet site 4 (Table 4.24, Fig. 4.22). The relative abundance of fishes in the littoral zone (as indicated by trapnet CUE) parallels the species composition data presented above (Table 4.25).

Eleven species were captured during index gillnetting. Brown bullhead and bluegill were the dominant species and northern pike, pumpkinseed, rock bass, yellow perch, and smallmouth bass were moderately abundant. Lake herring, white sucker, golden shiner, and black crappie were present but relatively uncommon. Lake herring was the only species caught in the gillnets which was not observed during trapnetting. Yellow bullhead and largemouth bass were the only species caught in the trapnets which did not also appear in the gillnet catch (Table 4.25).

The overall Shannon diversity index was 2.23 and ranged from 1.65 (site 6) to 2.23 (site 7) for individual trapnet locations (Fig. 4.23).

With respect to species composition, sites 1 and 2 had the highest percentage similarity, and with site 7 formed a group of similar trapnet locations. Sites 4 and 5 formed a second group of similar locations and 6 was the single most dissimilar site (Fig. 4.23).

Sites 1, 2, and 7 had the higher proportions of black crappie but lower percentages of brown bullhead than the other three sites (4, 5, and 6) (Table 4.24, 4.26). Sixty-two percent of the total variation between trapnet sites was accounted for by this difference (Table 4.27). The dissimilarity of site 6 was the result of the high relative abundance of bluegill (68%) and low proportion of black crappie (1.9%) found there compared to the other five sites (<47% and >6.3% respectively) (Tables 4.26, 4.27; Fig. 4.24).

4.4.2 Populations characteristics

Northern pike - The mean age of northern pike captured in the trapnets was 4.6 +/- 0.3 years, mean fork length was 46.6 +/- 2.2 cm, and mean weight was 699 +/- 119 g. Ages ranged from 4-12 years with the 1977 (age 5) year class the most abundant (Fig. 4.25).

The growth index for northern pike in Sydenham lake is lower than expected for Ontario populations (Table 4.28); however, the Walford and von Bertalanffy estimates (Table 4.29) predict

L_{∞} values higher than those calculated from 18 sets of Ontario northern pike data (MNR 1983). The instantaneous growth rate was 0.158 +/- 0.042 based on ages 3-6 (Fig. 4.26).

The total mortality rate for northern pike taken in the trapnets was 0.59 based on ages 4-8 (Table 4.30). This rate is similar to the provincial critical level of 0.60 (MNR 1983).

Blackspot was the most common external parasite observed on northern pike during trapnetting (32% occurrence) (Table 4.31).

Stomach content analysis showed that northern pike in Sydenham Lake are largely piscivorous. Only three of eight stomachs examined contained food; two contained fish remains and one contained Gastropoda.

Smallmouth bass - The mean age of smallmouth bass captured in the trapnets was 6.8 +/- 0.6 years, mean fork length was 31.4 +/- 2.2 cm, and mean weight was 614 +/- 147 g. Ages ranged from 4-12 years with the 1977 (age 5) year class the most abundant (Fig. 4.27).

The instantaneous growth rate was 0.125 +/- 0.011 based on ages 4-9 (Fig. 4.26). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.28).

The total mortality rate for smallmouth bass was 0.33 (based on ages 5-12). Because a second peak in abundance occurred at age 8, the mortality rate was also calculated for ages 8-12 (0.45) (Table 4.34). Both of the above rates are lower than the provincial critical level of 0.50 (MNR 1983).

Blackspot was the most common external parasite observed on smallmouth bass caught in the trapnets (21% occurrence) (Table 4.31).

Four of the 10 smallmouth bass stomachs examined were empty; the remainder contained largely digested material. The only food items recognizable were decapod and fish remains.

Largemouth bass - The mean age of largemouth bass caught in the trapnets was 6.6 +/- 0.3 years, mean fork length was 29.0 +/- 1.3 cm, and mean weight was 490 +/- 80 g. Ages ranged from 3-12 with the 1975 (age 7) year class the most abundant (Fig. 4.28).

The instantaneous growth rate was 0.116 +/- 0.018 based on ages 4-11 (Fig. 4.26). The fork length-at-age data did not fit the Walford or von Bertalanffy growth models (Table 4.29).

The total mortality rate for largemouth bass caught in the trapnets was 0.67 based on ages 7-10 (Table 4.30).

Sixty percent of the fish harvested in the summer sport fishery were age 7 or older (Schlesinger et al 1984). Thus, while probably not entirely representative of the angling impact on the Sydenham lake largemouth bass population, the above rate is relatively high and an increasing trend may indicate an overharvest situation.

External parasites affected a relatively low percentage of the largemouth bass sampled. Blackspot was the most common condition observed (5% occurrence) (Table 4.31).

Yellow perch - The mean age of the yellow perch caught in the trapnets was 7.0 +/- 0.4 years, mean fork length was 20.8 +/- 0.9, and mean weight was 144 +/- 19 g. Ages ranged from 4-11 years with the 1974 (age 8) year class the most abundant (Fig. 4.29).

The instantaneous growth rate was 0.099 +/- 0.030 based on ages 4-10 (Fig. 4.26).

The Walford (L_{∞}=31.7, k=0.217) and von Bertalanffy (L_{∞}=31.7, k=0.226, t =1.187, w=7.2) growth parameters were slightly greater than may be expected for Ontario populations (Table 4.29). The L_{∞} values were higher than the maximum population lengths reported for Ontario by Sheri and Power (1969) (25.7 cm, age 8) and Harkness (1922) (27.9, age 7).

The total mortality rate for yellow perch taken in the trapnets was 0.55 based on ages 8-11 (Table 4.30).

Blackspot was the most common external parasite observed on northern pike during trapnetting (63% occurrence) Table 4.31).

Stomach content analysis showed that Sydenham Lake yellow perch eat primarily invertebrates. Only three of the eight stomachs examined contained food; two stomachs contained Ephemeroptera nymphs and one contained Gastropoda.

Table 4.24 Species composition and total catch at Sydenham Lake during the June 16-25, 1982 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							
	TN1	TN2	TN4	TN5	TN6	TN7	ALL SITES	TOTAL CATCH
Northern pike	0.3	0.6	0.6	0.9	0.1	0.9	0.6	47
White sucker				0.1			<0.1	1
Golden shiner	0.1				0.2	2.1	0.2	14
Yellow bullhead	0.9	1.2	0.6	0.2	0.3		0.6	45
Brown bullhead	4.8	8.0	49.2	40.9	10.2	5.4	27.7	2260
Rock bass	7.3	3.6	1.7	3.6	3.6	4.3	3.4	281
Pumpkinseed	12.7	9.7	3.1	6.7	12.0	13.2	7.9	647
Bluegill	41.3	46.8	25.5	37.1	68.0	26.7	40.3	3290
Smallmouth bass		0.5	0.2	1.8	0.8		0.6	47
Largemouth bass	0.5	2.0	1.5	1.6	0.8	0.9	1.3	102
Black crappie	30.0	27.2	17.0	6.3	1.9	43.7	16.3	1328
Yellow perch	2.1	0.6	0.7	0.8	2.0	1.7	1.2	96
Total catch	1039	865	2812	1392	1617	423		8148
Percent catch	12.8	10.0	34.5	17.1	19.8	5.2	100.0	

Table 4.25 CUE for fishes caught at Sydenham Lake during 1982 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear Type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Lake herring		0.5
Northern pike	0.9	23.5
White sucker	<0.1	1.0
Golden shiner	0.3	1.5
Yellow bullhead	0.8	
Brown bullhead	41.9	24.0
Rock bass	5.2	11.5
Pumpkinseed	12.0	16.5
Bluegill	60.7	19.0
Smallmouth bass	0.9	5.5
Largemouth bass	1.9	
Black crappie	24.6	3.5
Yellow perch	1.8	6.0

[1] total number of trapnet lifts = 54
[2] total number of gillnet lifts = 2

Table 4.26 Differences between trapnet sites based on mean daily percentage composition data for each of the six most abundant species caught in trapnets at Sydenham Lake, June 16-25, 1982. Sites with at least one letter in common are not significantly different (tested using Tukey-Kramer analysis). The alphabetic order of the letters corresponds to the relative mean percentage of the species found at each site. For example: "a" represents those sites with the lowest mean, "b" the next highest, and so on.

Trapnet Site	Brown Bullhead	Rock Bass	Pumpkinseed	Bluegill	Largemouth Bass	Black Crappie
1	a	b	b,c	b	a	b
2	a	a,b	b,c	b	a	b
4	b	a	a	a,b	a	b
5	b	a,b	a,b	b	a	a
6	a	a,b	b,c	c	a	a
7	a	a,b	b,c	c	a	a

Table 4.27 First two principal components for the six most abundant species caught in trapnets at Sydenham Lake, June 16-25, 1982.

	Principal Component	
Species	1	2
Brown bullhead	0.8	-0.4
Rock bass	-0.1	0.1
Pumpkinseed	-0.2	0.2
Bluegill	-0.0	0.6
Largemouth bass	0.0	-0.0
Black crappie	-0.6	-0.7
Percent variance	62.0	35.6
Cumulative variance	62.0	97.6

Table 4.28 Mean fork length-at-age (cm), 95% confidence limits (CL), and growth indices (GI)[1] for fishes captured at Sydenham Lake, 1982.
Values in parentheses are sample sizes.

Species		III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	Mean Growth Index
Northern pike	mean	35.2	43.0	50.3	56.5	69.5							
	CL	2.5	1.7	1.6	11.2	NA							
	GI	76	82	87	90	104							88
		(5)	(18)	(14)	(4)	(1)							
Smallmouth bass	mean		22.0	24.3	27.4	30.8	36.1	40.7	44.0	44.5	45.3		
	CL		6.0	1.3	1.5	1.7	3.1	6.6	40.7	50.8	NA		
			(4)	(12)	(6)	(7)	(5)	(4)	(2)	(2)	(1)		
Largemouth bass	mean	13.8	19.5	22.5	26.4	29.6	35.4	35.0	40.9	44.3		41.3	
	CL	NA	3.3	1.3	1.2	1.2	1.7	6.3	NA	6.4		NA	
		(1)	(5)	(8)	(25)	(29)	(7)	(4)	(1)	(2)		(1)	
Yellow perch	mean	15.9	15.1	17.6	21.4	23.4	24.7	26.3	27.7				
	CL	1.2	0.8	1.2	1.7	1.0	2.2	4.4	24.8				
		(12)	(16)	(14)	(11)	(17)	(12)	(4)	(2)				

[1]Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for northern pike (MNR (1983).

Table 4.29 Walford and von Bertalanffy growth parameters for target species caught at Sydenham Lake during index trapnetting June 16-25, 1982.
Blank spaces indicate data which did not fit the von Bertalanffy model.
NC denotes "not calculated".

		Walford			von Bertalanffy				
Species	Ages	Loo(cm)	K	R^2	Loo(cm)	K	t_o	W[1]	R^2
Northern pike	3 - 6	110.1	0.111	0.99	110.1	0.112	-0.440	12.3	0.99
Smallmouth bass	4 - 8	32.0	1.317	0.10					
Largemouth bass	5 - 8	39.1	0.347	0.78					
Yellow perch	4 - 8	31.7	0.217	0.94	31.7	0.226	1.187	7.2	0.98

[1]W = K x Loo (Gallucci and Quinn 1979), based on a linear regression of Ln(Loo-Lt) against age.

Table 4.30 Total mortality rates for target species captured at Sydenham Lake during index trapnetting June 16-25, 1982.

Species	Mortality Rate	Confidence Interval	Ages
Northern pike	0.59	0.36 - 0.74	4 - 8
Smallmouth bass	0.33	0.18 - 0.45	5 - 12
	0.45	0.04 - 0.69	8 - 12
Largemouth bass	0.67	0.28 - 0.85	7 - 10
Yellow perch	0.55	0.12 - 0.77	8 - 11

Table 4.31 The percent occurrence of visible external parasites for target species sampled during trapnetting at Sydenham Lake, June 16-25, 1982.
Blank spaces denote that no parasites were observed.

		Parasite				
Species	No.	Blackspot	Gill Fluke	Red Sore	Yellow Grub	Fin Rot
Northern pike	44	32		5		
Smallmouth bass	42	21	5			
Largemouth bass	96	5	1			1
Yellow perch	94	63	2		3	

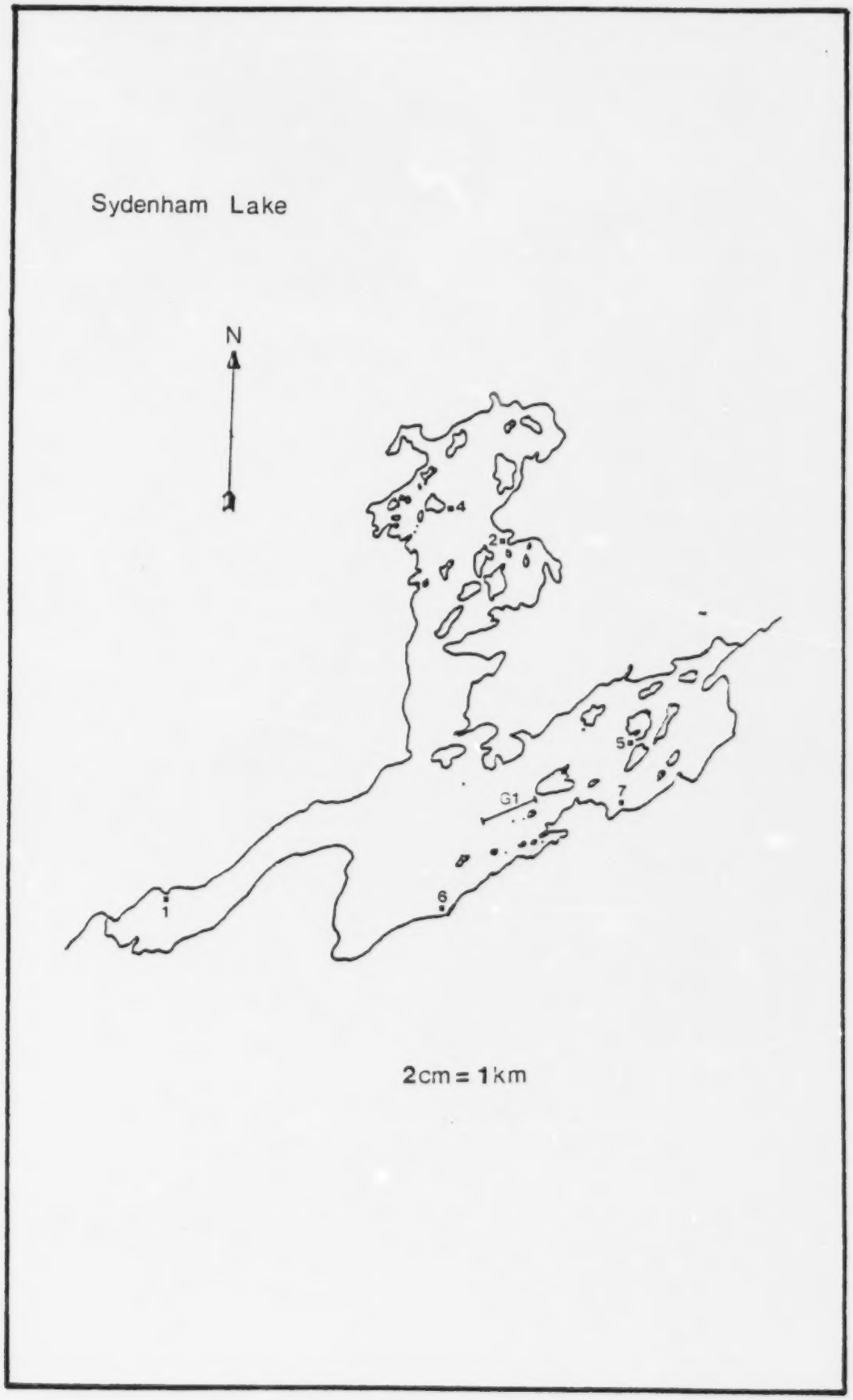

Figure 4.22 Index netting gear locations on Sydenham Lake, 1982.
■ = trapnet location
G⊢⊣ = gillnet location

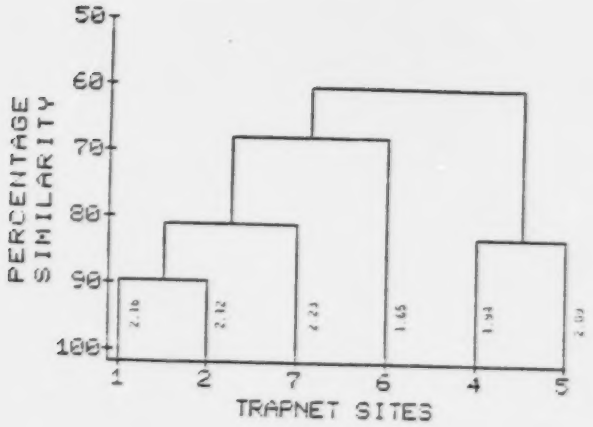

Figure 4.23 The percentage similarity between the trapnet sites on Sydenham Lake, 1982. The number next to each cluster is the diversity index for the respective sites.

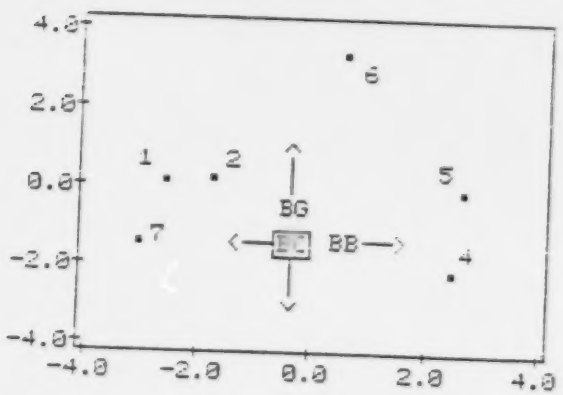

Figure 4.24 The major differences in species composition between the Sydenham Lake trapnet sites, 1982. The arrows on each axis (principal component) indicate the direction of increasing proportional abundance of the designated species. BB, brown bullhead; BC, black crappie; BG, bluegill.

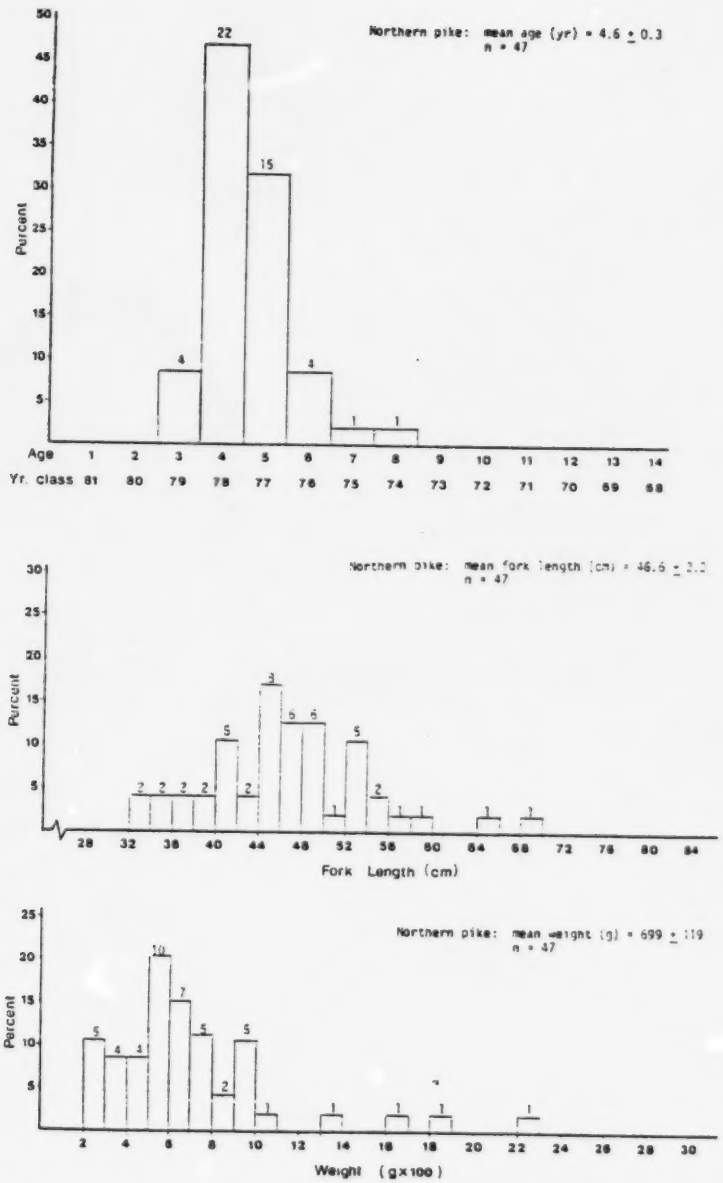
Northern pike: mean age (yr) = 4.6 ± 0.3
n = 47
Percent
Age
Yr. class
Northern pike: mean fork length (cm) = 46.6 ± 2.2
n = 47
Fork Length (cm)
Northern pike: mean weight (g) = 699 ± 119
n = 47
Weight (gx100)

Figure 4.25 Age, fork length, and weight distributions of northern pike captured in trapnets at Sydenham Lake, 1982. Numbers over each bar indicate actual count frequencies.

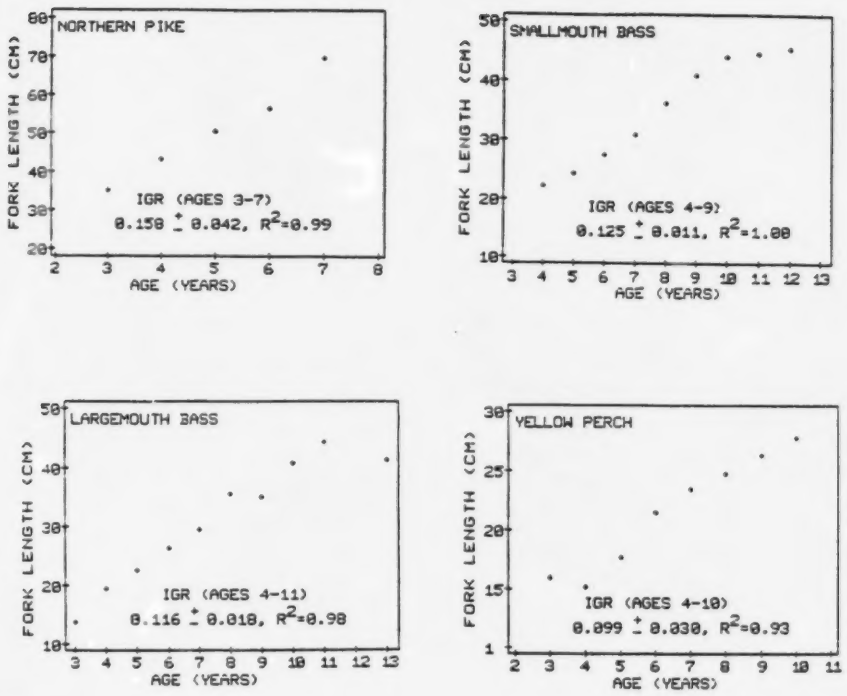

Figure 4.26 Absolute growth rate of northern pike, smallmouth bass, largemouth bass, and yellow perch sampled during index trapnetting at Sydenham Lake, 1982. The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

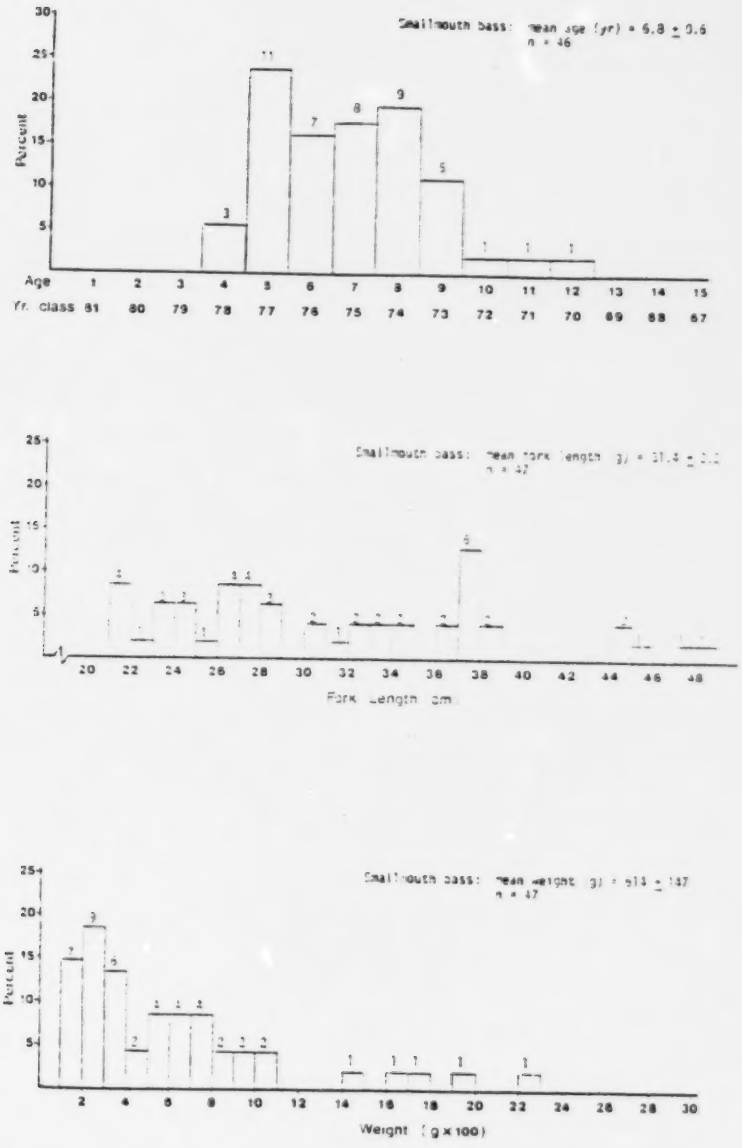

Figure 4.27 Age, fork length, and weight distributions of smallmouth bass captured in trapnets at Sydenham Lake, 1982. Numbers over each bar indicate actual count frequencies.

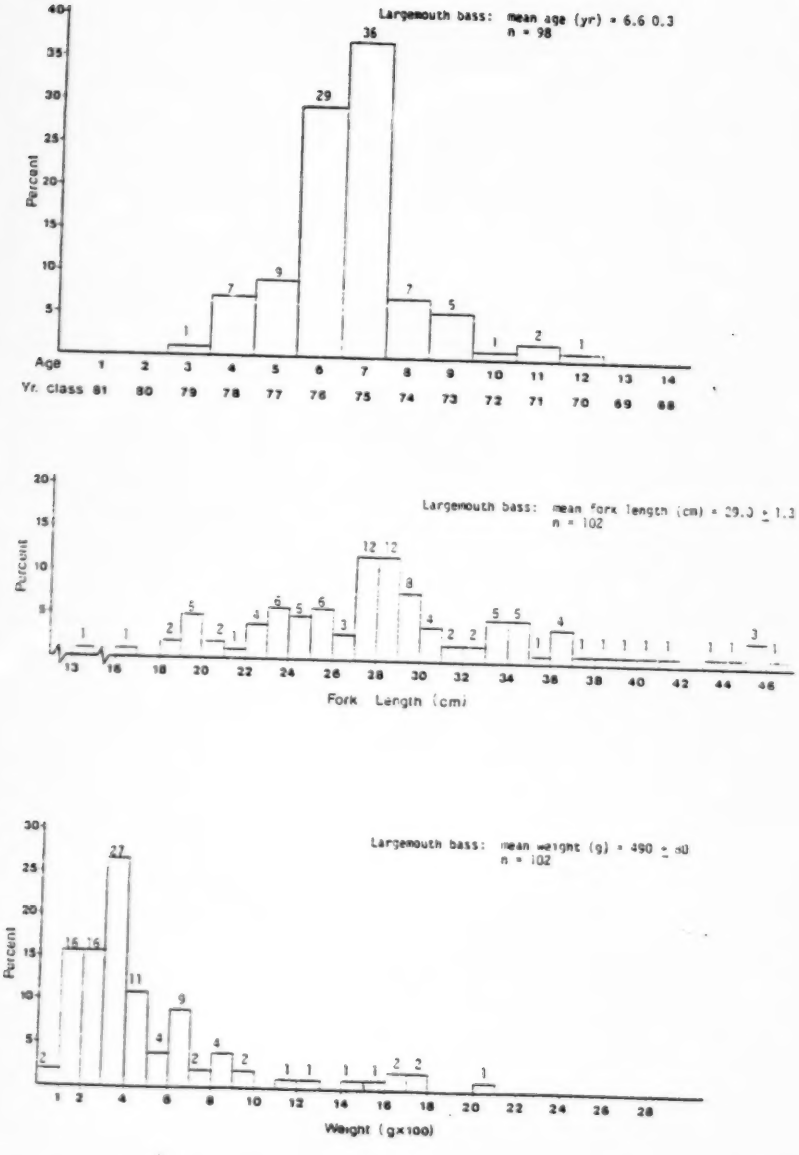

Figure 4.28 Age, fork length, and weight distributions of largemouth bass captured in trapnets at Sydenham Lake, 1982. Numbers over each bar indicate actual count frequencies.

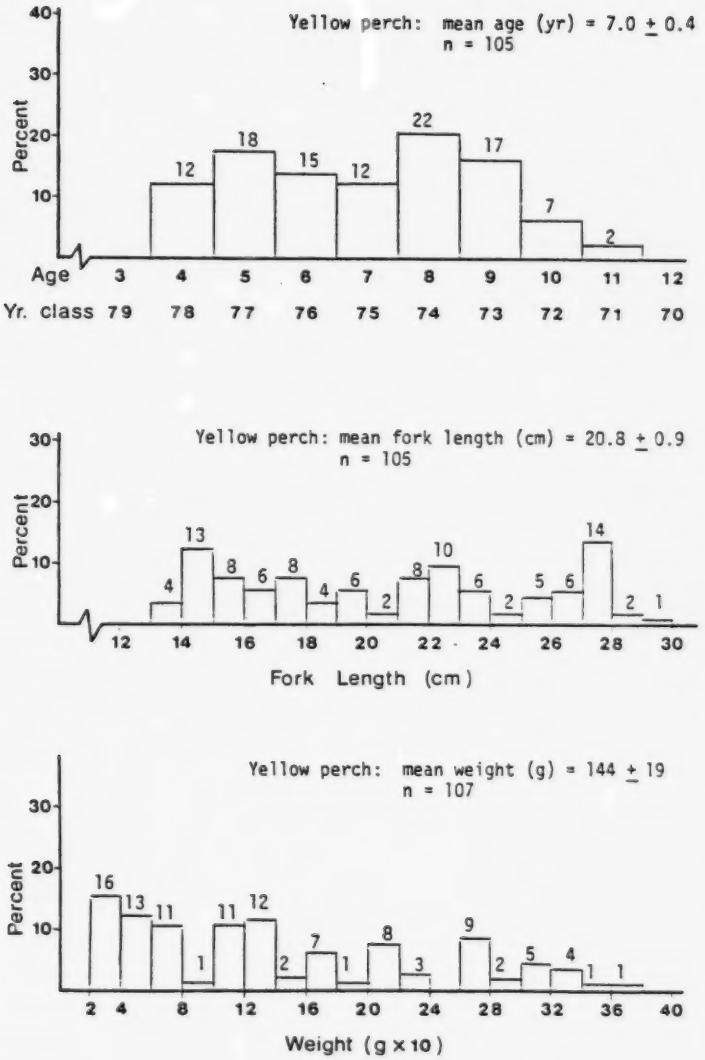

Figure 4.29 Age, fork length, and weight distributions of yellow perch captured in trapnets at Sydenham Lake, 1982. Numbers over each bar indicate actual count frequencies.

4.5 UPPER RIDEAU LAKE

4.5.1 Community structure

Species composition - Adults and juveniles - Pumpkinseed (31.5%) comprised the greatest percentage of the catch, followed by bluegill (23.4%), yellow perch (16.0%), rock bass (10.4%), brown bullhead (4.6%), smallmouth bass (4.4%), black crappie (2.6%), largemouth bass (2.0%), northern pike (1.8%), alewife (1.0%), and white sucker (1.0%). Shorthead redhorse, golden shiner, yellow bullhead, american eel, burbot, and walleye each made up <1% of the catch. Most of the fish were caught at trapnet sites 7 and 5 (Table 4.32, Fig. 4.30). The relative abundance of fishes in the littoral zone (as indicated by trapnet CUE) generally parallels the species composition data presented above (Table 4.33).

Eleven species were caught during the index gillnetting and each of these were also captured in the trapnets. Alewife which was uncommon in the trapnets, was the most abundant species in the gillnet catch. Yellow perch and pumpkinseed were moderately abundant and the remaining species, northern pike, white sucker, yellow bullhead, brown bullhead, rock bass, smallmouth bass, largemouth bass, and walleye were present but relatively uncommon (Table 4.33).

The overall Shannon diversity index was 2.78 and ranged from 2.00 (site 5) to 2.96 (site 6) for individual trapnet locations (Fig. 4.31).

With respect to species composition, sites 2 and 4 had the highest percentage similarity, and with site 7 formed a group of similar trapnet locations. Sites 1 and 5 formed a second group of similar locations and site 6 was the most dissimilar (Fig. 4.31).

The primary reason for the dissimilarity of sites 2, 4, and 7 from 1, 5, and 6 was the proportion of yellow perch, brown bullhead, and bluegill caught at each site. In addition, sites 2 (29.4%), 4 (32.7%), and 7 (34.6%) had a higher percentage of bluegill than site 1 (17.4%), and a significantly higher percentage than sites 5 (9.7%), and 6 (9.8%) (Tables 4.32, 4.34; Fig. 4.32).

The dissimilarity of site 6 from all other sites was primarily the result of a significantly higher proportion of smallmouth bass (22.0%) compared to all other locations (<8.0%). Site 6 also had a significantly higher proportion of rock bass (19.7%) than all other locations (<9.0%), with the exception of site 5 (15.3%). Also, significantly more brown bullhead (15.9%) were caught at site 6 than at any other site (<9%). (Tables 4.32, 4.34).

The contrasts described above accounted for 94% of the variation among the trapnet locations (Table 4.35).

Larval fish - Overall, alewife (79.1%) comprised the greatest percentage of the total catch, followed by yellow perch (10.9%) and black crappie (9.2%). Rock bass (0.3%) and an

unidentified Cyprinidae (0.1%) were also caught.

Peak catches of yellow perch (139.8 fish/1000 cubic meters) and black crappie (66.5 fish/1000 cubic meters) occurred on May 17 and June 14 respectively (Fig. 4.37). Nevertheless, after hatching in late May, alewife dominated the catch at all locations and depths. The peak alewife catch also occurred on June 14 (791.8 fish/1000 cubic metres).

In general, midwater trawls caught fewer fish than either the littoral zone sled trawls or the offshore surface trawls. No distinct seasonal onshore or offshore movements were observed (Fig. 4.34).

4.5.2 Population characteristics

Northern pike - The mean age of northern pike caught in the trapnets was 4.7 +/- 0.2 years, mean fork length was 53.7 +/- 1.0 cm, and mean weight was 1228 +/- 71 g. Ages ranged from 2-9 years with the 1977 (age 5) year class the most abundant (Fig. 4.35).

The growth rate of northern pike in Upper Rideau appears to be slightly lower than the provincial standard. The growth index of the most abundant year class (age 5) and for all ages was 96% (Table 4.36). The instantaneous growth rate was 0.089 +/- 0.024 based on ages 2-9 (Fig. 4.36). The Walford (L_{∞}=78.1, k=0.154) and von Bertalanffy (L_{∞}=78.1, k=0.151, t =-3.125, w=11.8) were also slightly below those calculated from 18 sets of Ontario data (L_{∞}=98.3, k=0.145, t =-2.169, w=14.3) (MNR 1983) (Table 4.37).

The total mortality rate for northern pike taken in the trapnets was 0.75 (based on ages 5-8) (Table 4.38); exceeding the provincial standard (0.60) (MNR 1983).

External parasites affected a relatively low percentage of the northern pike. Red sore was the most common condition (8% occurrence) (Table 4.39).

Individual food items could not be recognized in any of the four northern pike stomachs examined.

Smallmouth bass - The mean age of smallmouth bass caught in the trapnets was 8.0 +/- 0.1 years, mean fork length was 36.5 +/- 0.5 years, and mean weight was 948 +/- 42 g. Ages ranged from 4-13 years with the 1974 and 1975 (ages 7 and 8) the most abundant (Fig. 4.37).

The instantaneous growth rate was 0.111 +/- 0.030 based on ages 4-12 (Fig. 4.36).

The Walford (L_{∞}=62.3, k=0.127) and von Bertalanffy (L_{∞}=62.3, k=0.134, t =1.267, w=8.3) growth models provided a good fit to FL-at-age data (Tables 4.36, 4.37).

The total mortality rate for smallmouth bass taken in the trapnets was 0.48 based on ages 7-13 (Table 4.38) and was similar to the critical level (0.50) (MNR 1983).

Blackspot was the only external parasite observed on smallmouth bass during trapnetting (3% occurrence) (Table 4.39).

Over 50% of the 14 smallmouth bass stomachs examined

contained recognizable fish remains. Three stomachs were empty.

Largemouth bass - The mean age of largemouth bass caught in the trapnets was 7.5 +/- 0.3 years, mean fork length was 31.8 +/- 0.9 cm, and mean weight was 712 +/- 66 g. Ages ranged from 2-14 with the 1974, 1975, and 1976 year classes (ages 6, 7, and 8) the most abundant (Fig. 4.38).

The instantaneous growth rate was 0.122 +/- 0.022 based on ages 3-11 (Fig. 4.36).

The Walford and von Bertalanffy growth models both provided a good fit to the FL-at-age data (Tables 4.36, 4.37). The L_{∞} estimates approach the maximum total length-at-age for Ontario largemouth bass (53.3 cm) reported by MacKay (1963).

The total mortality rate for largemouth bass caught in the trapnets was 0.60 based on ages 8-12 (Table 4.38). A larger sampling of the younger age classes is required to adequately assess the sport fishery impact on the Upper Rideau lake largemouth bass population.

External parasites affected a relatively low percentage of the largemouth bass sampled in the trapnets. Blackspot was the most common condition (3% occurrence) (Table 4.39).

Yellow perch- The mean age of the yellow perch caught in the trapnets was 6.6 +/- 0.1 years, mean fork length was 20.9 +/- 0.1 cm, and mean weight was 135 +/- 3 g. Ages ranged from 4-11 years with the 1975 (age 7) year class the most abundant (Fig. 4.39).

The instantaneous growth rate was 0.080 +/- 0.017 based on ages 4-11 (Fig. 4.36).

The Walford (L_{∞}=39.3, k=0.100) and von Bertalanffy (L_{∞}=39.3, k=0.112, t =-0.578, w=4.4) growth parameters were greater than may be expected for Ontario populations. The L_{∞} values even exceed the Ontario record of 36.3 cm (Scott and Crossman 1973).

The total mortality rate for yellow perch taken in the trapnets was 0.76 based on ages 7-11 (Table 4.38).

External parasites were observed on <2% of the fish examined (Table 4.39).

Nine out of 10 yellow perch stomachs examined contained food; of these, 66.6% contained chironomid larvae, 22.2% Isopoda , 33.3% plant matter and 44.4% unidentifiable digested material.

Walleye - The mean age of the walleye caught in the trapnets was 11.9 +/- 0.5 years, mean fork length was 62.0 +/- 1.3 cm, and mean weight was 3222 +/- 175 g. Ages ranged from 6-17 years with the 1970 (age 12) year class the most abundant (Fig. 4.40).

The instantaneous growth rate was 0.074 +/- 0.021 based on ages 6-10 (Fig. 4.36). There was insufficient FL-at-age data to run either the Walford or von Bertalanffy growth models (Table 4.36).

The total mortality rate for walleye was 0.65 based on ages

12-15 (Table 4.38); exceeding the provincial standard (0.50) (MNR 1983).

External parasites affected <1% of the walleye sampled during trapnetting (Table 4.39). (Note: adult walleye (>3kg) floating dead on the surface were reported to creel survey technicians on several occasions. The cause of death is unknown as these walleye were free of external parasites and lacked angling scars. Water quality profiling revealed suitable walleye habitat above the thermocline (G. Ridout, personal communication).

Stomach content analysis on four walleye from Upper Rideau Lake showed that these fish are primarily piscivorous. Twenty-five percent of the walleye stomachs examined contained fish remains; all stomachs contained unidentified digested matter.

Walleye were observed at the Westport channel spawning site from April 9-25, 1982 (temperature range: 3.0-11.5 C). Twenty-two walleye were observed on April 19th at the peak of the run. Although spawning activity centred around the substrate rehabilitated in 1980 (Mabee and MacDonald 1981), the entire area was covered with heavy algae growth; conditions unfavourable for successful incubation of any deposited eggs.

Priegal (1970) found that larval walleye depend largely upon the availability of a suitable food supply in the lake environment within 3 to 5 days of hatching. Plankton sampling on Upper Rideau Lake on May 11, 1982 indicated the presence of numerous rotifer and crustacean species that are documented food items of larval walleye (Colby et al. 1979 ; RLFAU 1982).

Table 4.32 Species composition and total catch at Upper Rideau Lake during the May 5-14, 1982 index trapnetting. Blank spaces denote no catch.

Species	Trapnet Percent Composition							
	TN1	TN2	TN4	TN5	TN6	TN7	ALL SITES	TOTAL CATCH
Alewife	1.5	0.2	0.4	0.1	0.3	2.2	1.0	118
Northern pike	3.1	4.6	2.6	0.1	2.0	1.1	1.8	207
White sucker	2.8	0.9	0.8		1.0	0.9	1.0	116
Shorthead redhorse	<0.1				0.2		<0.1	2
Golden shiner		0.1	1.5		0.2	0.2	0.3	33
Yellow bullhead	0.3	0.3	2.2		0.5	0.3	0.5	56
Brown bullhead	3.4	5.8	8.7	0.4	15.9	4.6	4.6	530
American eel			0.1				<0.1	1
Burbot			<0.1				<0.1	1
Rock bass	8.6	8.2	5.0	15.3	19.7	8.9	10.4	1204
Pumpkinseed	25.6	31.8	30.4	37.2	16.9	33.1	31.5	3640
Bluegill	17.4	29.4	32.7	9.7	9.8	34.6	23.4	2700
Smallmouth bass	1.2	1.3	1.6	1.7	22.0	7.6	4.4	504
Largemouth bass	2.6	4.5	2.0		2.0	2.5	2.0	231
Black crappie	4.3	2.8	3.9	0.6	1.0	2.8	2.6	298
Yellow perch	28.7	9.5	7.6	34.8	2.6	0.9	16.0	1849
Walleye	0.4	0.5	0.5		6.1	0.4	0.6	72
Total catch	2027	1165	1467	2870	605	3428		11562
Percent catch	17.5	10.1	12.7	24.8	5.2	29.6	100.0	

Table 4.33 CUE for fishes caught at Upper Rideau Lake during 1982 by trapnet and gillnet. Blank spaces denote no catch.

Species	Observed CUE by Gear Type	
	Trapnet[1] (#/lift)	Gillnet[2] (#/lift)
Alewife	2.2	216.3
Northern pike	3.9	3.3
White sucker	2.2	1.3
Shorthead redhorse	<0.1	
Golden shiner	0.6	
Yellow bullhead	1.1	0.7
Brown bullhead	10.0	2.3
American eel	<0.1	
Burbot	<0.1	
Rock bass	22.7	23.3
Pumpkinseed	68.7	61.0
Bluegill	50.9	3.0
Smallmouth bass	9.5	4.7
Largemouth bass	4.4	
Black crappie	5.6	
Yellow perch	34.9	101.0
Walleye	1.4	2.3

[1]total number of trapnet lifts = 53
[2]total number of gillnet lifts = 3

Table 4.34 Differences between trapnet sites based on mean daily percentage composition data for each of the six most abundant species caught in trapnets at Upper Rideau Lake, May 5-14, 1982. Sites with at least one letter in common are not significantly different (tested using Tukey-Kramer analysis). The alphabetic order of the letters corresponds to the relative mean percentage of the species found at each site. For example: "a" represents those sites with the lowest mean, "b" the next highest, and so on.

Trapnet Site	Brown Bullhead	Rock Bass	Pumpkinseed	Bluegill	Smallmouth Bass	Yellow Perch
1	a,b	a,b	a,b	a,b	a	c
2	b	a,b	a,b	b	a	b
4	b	a	a,b	b	a	a,b
5	a	b,c	b	a	a	c
6	c	c	a	a	c	a,b
7	a,b	a,b	a,b	b	b	a

Table 4.35 First two principal components for the six most abundant species caught in trapnets at Upper Rideau Lake, May 5-14, 1982.

	Principal Component	
Species	1	2
Brown bullhead	0.4	0.1
Rock bass	0.0	0.4
Pumpkinseed	-0.2	-0.2
Bluegill	0.1	-0.7
Smallmouth bass	0.5	0.5
Yellow perch	-0.8	0.3
Percent variance	60.9	32.4
Cumulative variance	60.9	93.5

Table 4.36 Mean fork length-at-age (cm), 95% confidence limits (CL), and growth indices (GI)[1] for fishes captured at Upper Rideau Lake, 1982.
Values in parentheses are sample sizes.

Species		Age I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	Mean Growth Index
Northern pike	mean		36.8	47.0	51.6	55.3	58.0	61.3	64.8	78.6						
	CL		6.5	3.7	1.7	1.2	4.7	4.9	6.5	38.1						
	GI		99	102	98	96	93	92	89	98						96
			(4)	(19)	(48)	(59)	(13)	(8)	(3)	(2)						
Smallmouth bass	mean				18.0	24.7	29.7	33.1	36.2	40.6	43.6	45.0	47.9	45.0		
	CL				7.5	5.3	1.0	1.1	1.6	1.2	1.7	2.5	2.2	33.0		
					(5)	(6)	(23)	(37)	(29)	(28)	(15)	(9)	(4)	(2)		
Largemouth bass	mean	2.4		15.5	19.9	24.4	27.0	30.5	33.6	37.4	39.6	44.2	41.3	43.8	49.7	
	CL	NA		18.4	1.5	1.9	1.8	1.4	1.1	1.7	4.3	2.6	NA	5.2	NA	
		(1)		(2)	(8)	(15)	(22)	(25)	(30)	(17)	(6)	(5)	(1)	(5)	(1)	
Yellow perch	mean				16.5	18.2	19.4	22.1	24.9	26.6	26.8	27.9				
	CL				0.3	1.4	1.2	1.0	1.0	1.1	0.8	NA				
					(23)	(11)	(20)	(26)	(25)	(23)	(10)	(1)				
Walleye	mean						43.0	45.1	51.2	52.6	57.6					
	CL						NA	NA	14.0	NA	3.9					
	GI						100	98	103	100	104					101
							(1)	(1)	(2)	(1)	(6)					

[1] Growth Index (GI) = (fork length/growth standard fork length) x 100 (MNR 1983).
Of the target species sampled, growth standards have been established only for northern pike (MNR (1983).

Table 4.37 Walford and von Bertalanffy growth parameters for target species caught at Upper Rideau Lake during index trapnetting May 5-14, 1982.
Blank spaces indicate data which did not fit the von Bertalanffy model.
NC denotes "not calculated".

Species	Ages	Walford Loo(cm)	K	R^2	von Bertalanffy Loo(cm)	K	t_o	W[1]	R^2
Northern pike	3 - 7	78.1	0.154	0.99	78.1	0.151	-3.125	11.8	0.99
Smallmouth bass	4 - 13	49.1	0.247	0.96	49.1	0.263	2.266	8.3	0.96
Largemouth bass	5 - 13	50.8	0.163	0.97	50.8	0.175	1.405	8.9	0.99
Yellow perch	4 - 10	39.3	0.100	0.94	39.3	0.112	-0.578	4.4	0.97
Walleye					NC				

[1] W = K x Loo (Ballucci and Quinn 1979), based on a linear regression of Ln(Loo-Lt) against age.

Table 4.38 Total mortality rates for target species captured at Upper Rideau Lake during index trapnetting June 16-25, 1982.

Species	Mortality Rate	Confidence Interval	Ages
Northern pike	0.75	0.25 - 0.92	5 - 8
Smallmouth bass	0.48	0.37 - 0.57	7 - 13
Largemouth bass	0.60	0.37 - 0.75	8 - 12
Yellow perch	0.76	0.54 - 0.87	7 - 11
Walleye	0.65	0.16 - 0.86	12 - 15

Table 4.39 The percent occurrence of visible external parasites for target species sampled during trapnetting at Upper Rideau Lake, May 5-14, 1982.
Blank spaces denote that no parasites were observed.

		Parasite				
Species	No.	Blackspot	Red Sore	Yellow Grub	Lymphocystes	Fin Rot
Northern pike	156	4	8			2
Smallmouth bass	200	3				
Largemouth bass	178	3				1
Yellow perch	143	1		1		
Walleye	67				1	

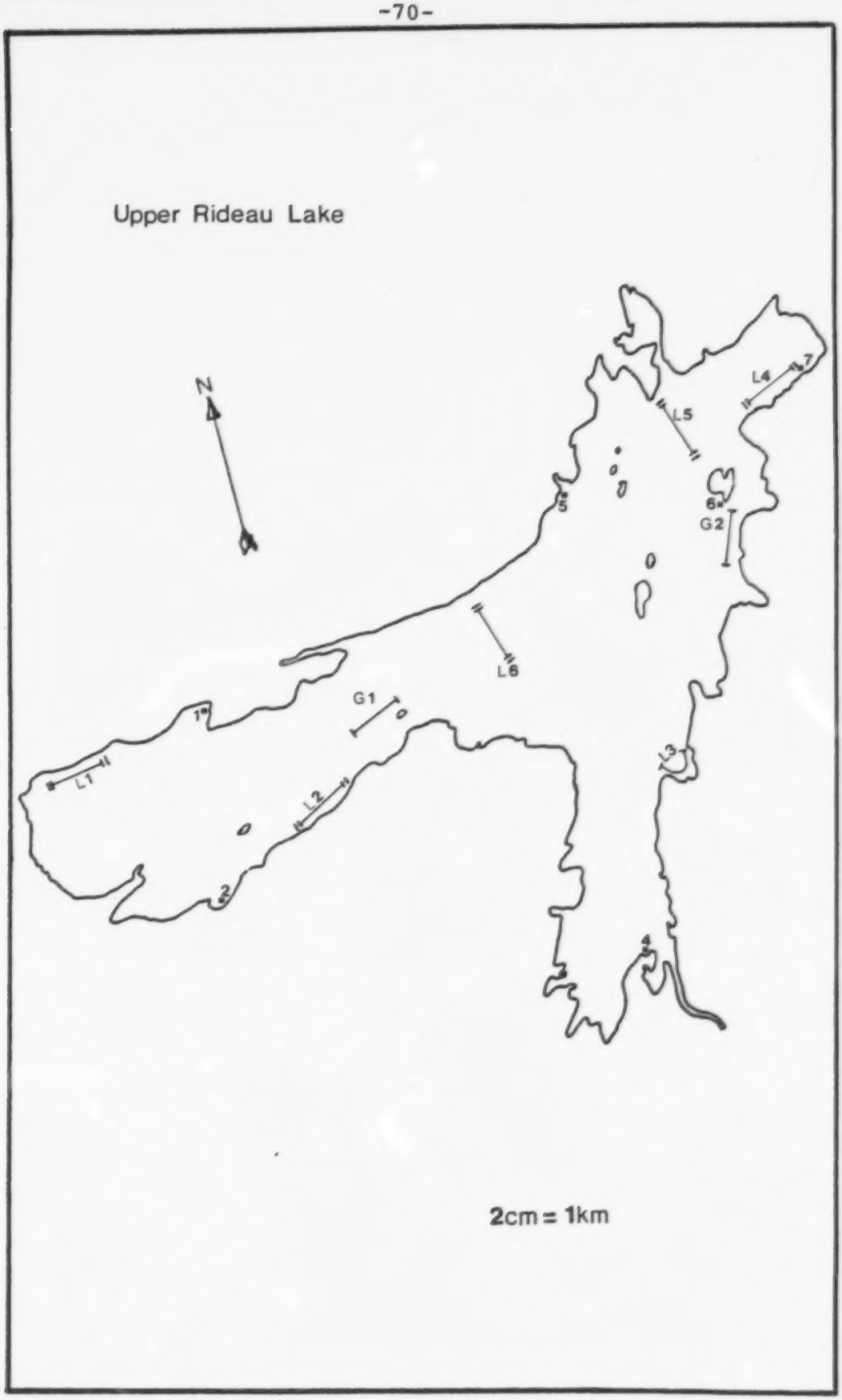

Figure 4.30 Index netting gear locations on Upper Rideau Lake, 1982.

■ = trapnet location
G⊢⊣ = gillnet location
L⊢⊣ = larval trawling location

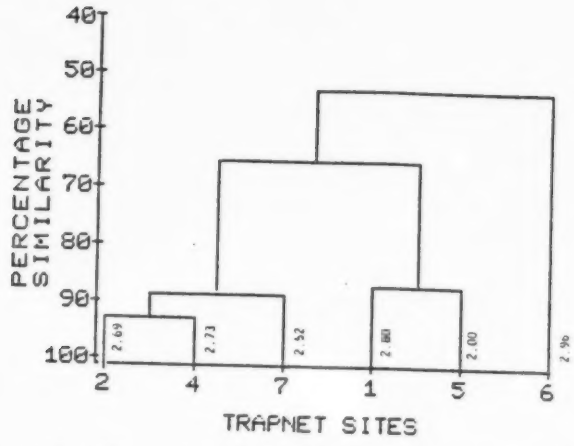

Figure 4.31 The percentage similarity between the trapnet sites on Upper Rideau Lake, 1982. The number next to each cluster is the diversity index for the respective sites.

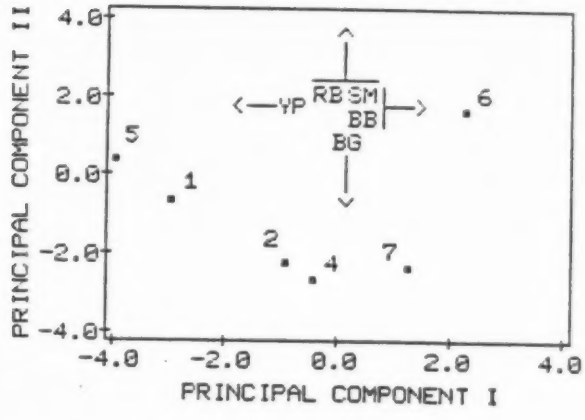

Figure 4.32 The major differences in species composition between Upper Rideau Lake trapnet sites, 1982. The arrows on each axis (principal component) indicate the designated species. SM, smallmouth bass; BB, brown bullhead; RB, rock bass; YP, yellow perch; BG, blue bluegill.

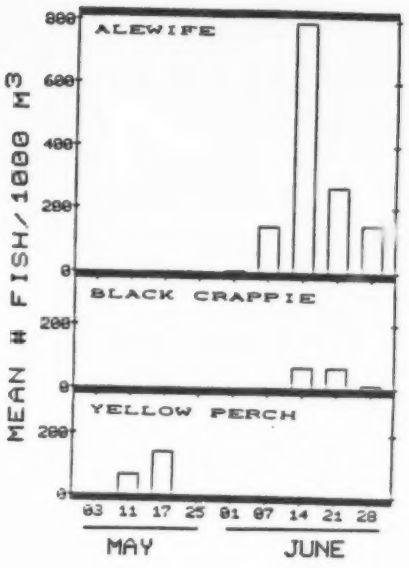

Figure 4.33 Mean catch of alewife, black crappie, and yellow perch in larval fish trawls (all trawls types and locations combined) during May 3 to June 28, 1982 at Upper Rideau Lake.

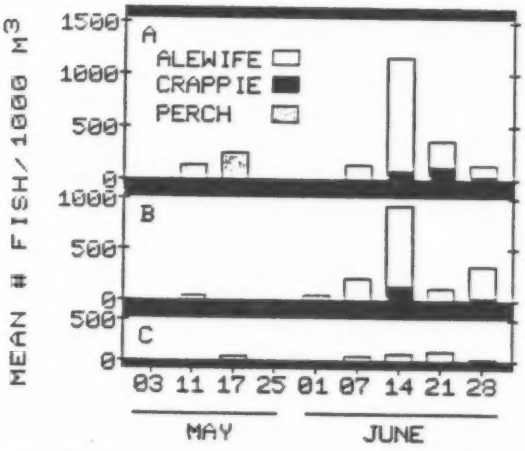

Figure 4.34 Mean catch of alewife, black crappie, and yellow perch in A) littoral zone sled trawls, B) surface trawls, and C) middepth trawls during May 3 to June 28, 1982 at Upper Rideau Lake.

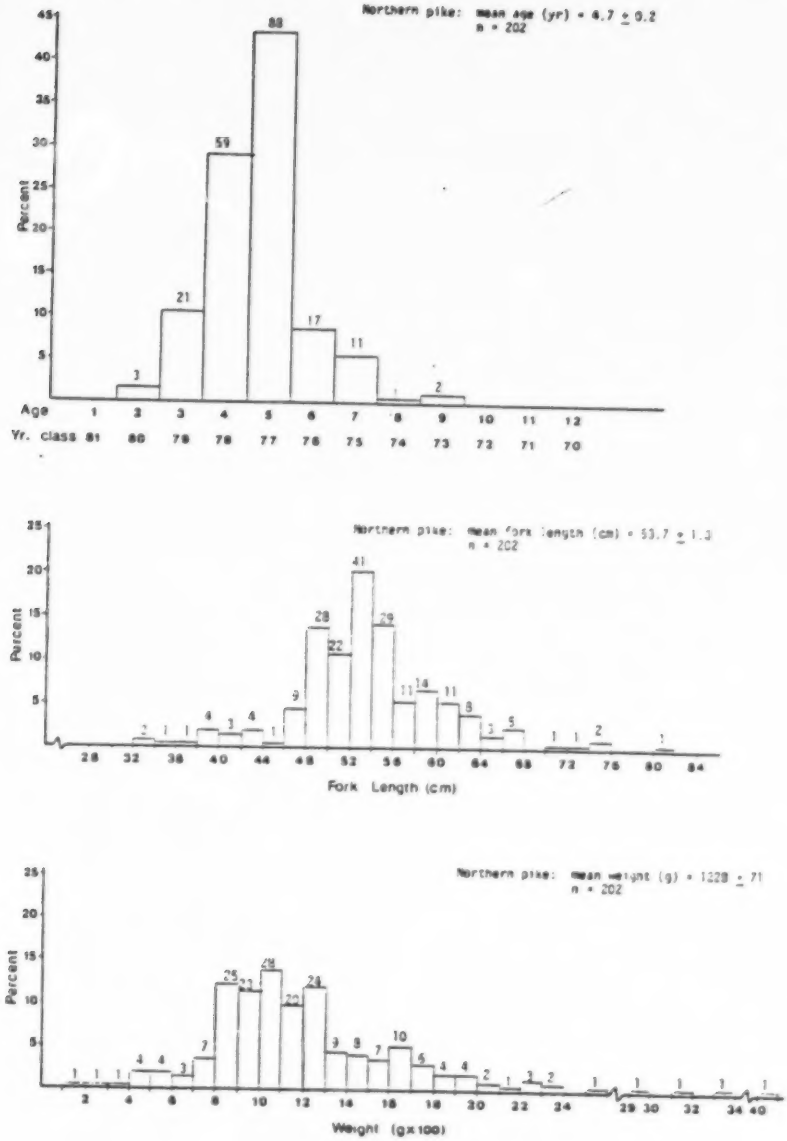
Northern pike: mean age (yr) = 4.7 ± 0.2
n = 202
Percent
Age
Yr. class
Northern pike: mean fork length (cm) = 53.7 ± 1.3
n = 202
Fork Length (cm)
Northern pike: mean weight (g) = 1328 ± 71
n = 202
Weight (gx100)

Figure 4.35 Age, fork length, and weight distributions of northern pike captured in trapnets at Upper Rideau Lake, 1982. Numbers over each bar indicate actual count frequencies.

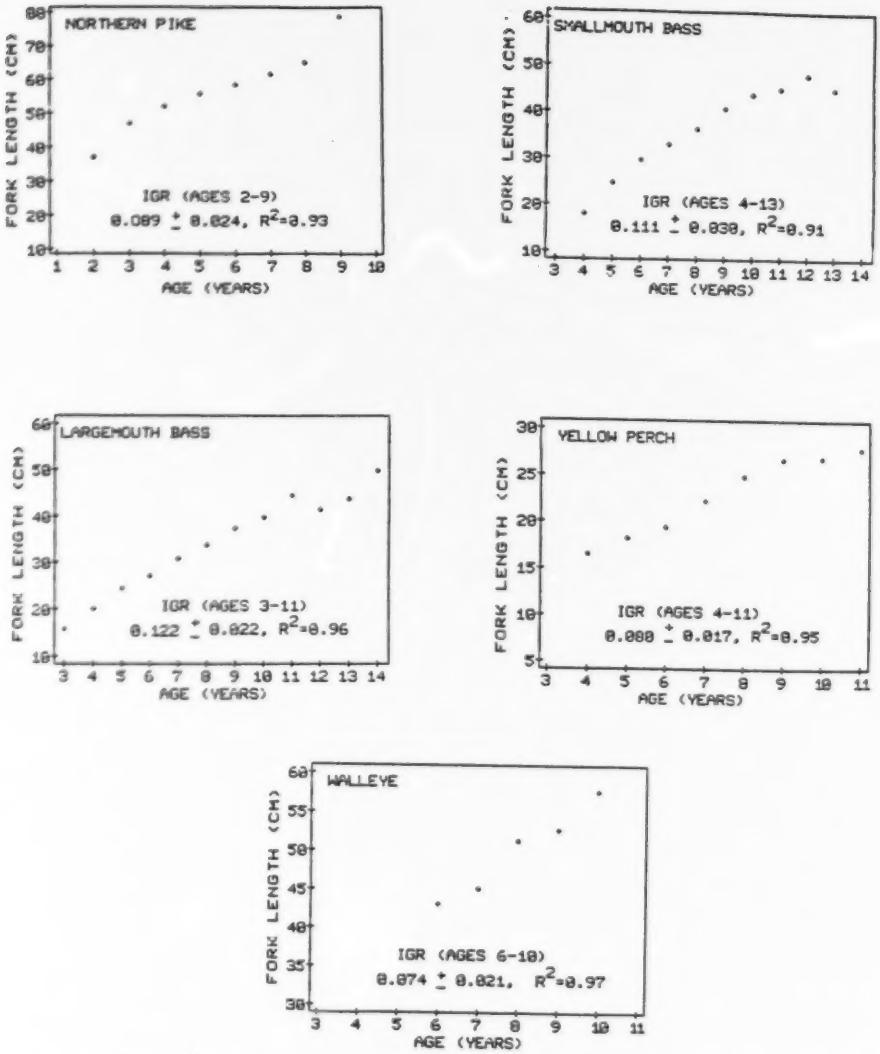

Figure 4.36 Absolute growth rate of northern pike, smallmouth bass, largemouth bass, yellow perch and walleye sampled during index trapnetting at Upper Rideau Lake, 1982.
The instantaneous growth rate (IGR), its 95% confidence limit, the age interval upon which the IGR was based, and the R-squared value from the regression procedure used to determine the IGR are shown for each species.

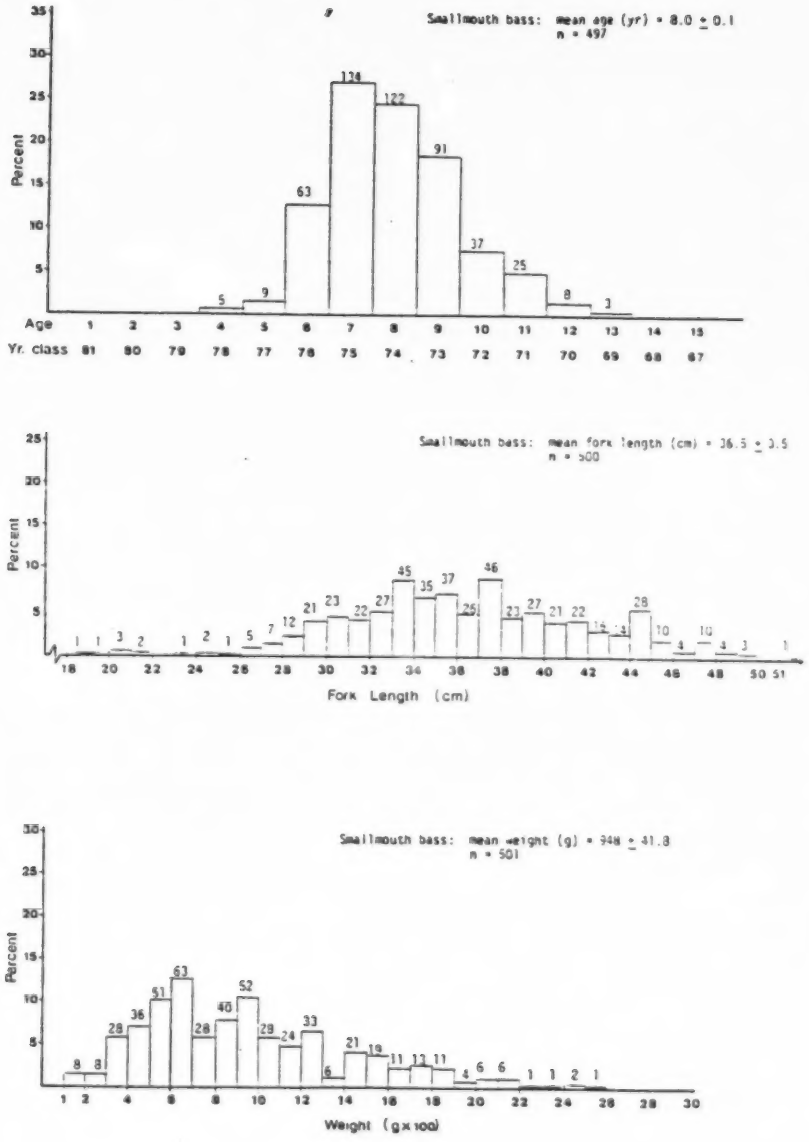
Smallmouth bass: mean age (yr) = 8.0 ± 0.1
n = 497
Percent
Age
Yr. class
Smallmouth bass: mean fork length (cm) = 36.5 ± 3.5
n = 500
Fork Length (cm)
Smallmouth bass: mean weight (g) = 948 ± 41.8
n = 501
Weight (g x 100)

Figure 4.37 Age, fork length, and weight distributions of smallmouth bass captured in trapnets at Upper Rideau Lake, 1982. Numbers over each bar indicate actual count frequencies.

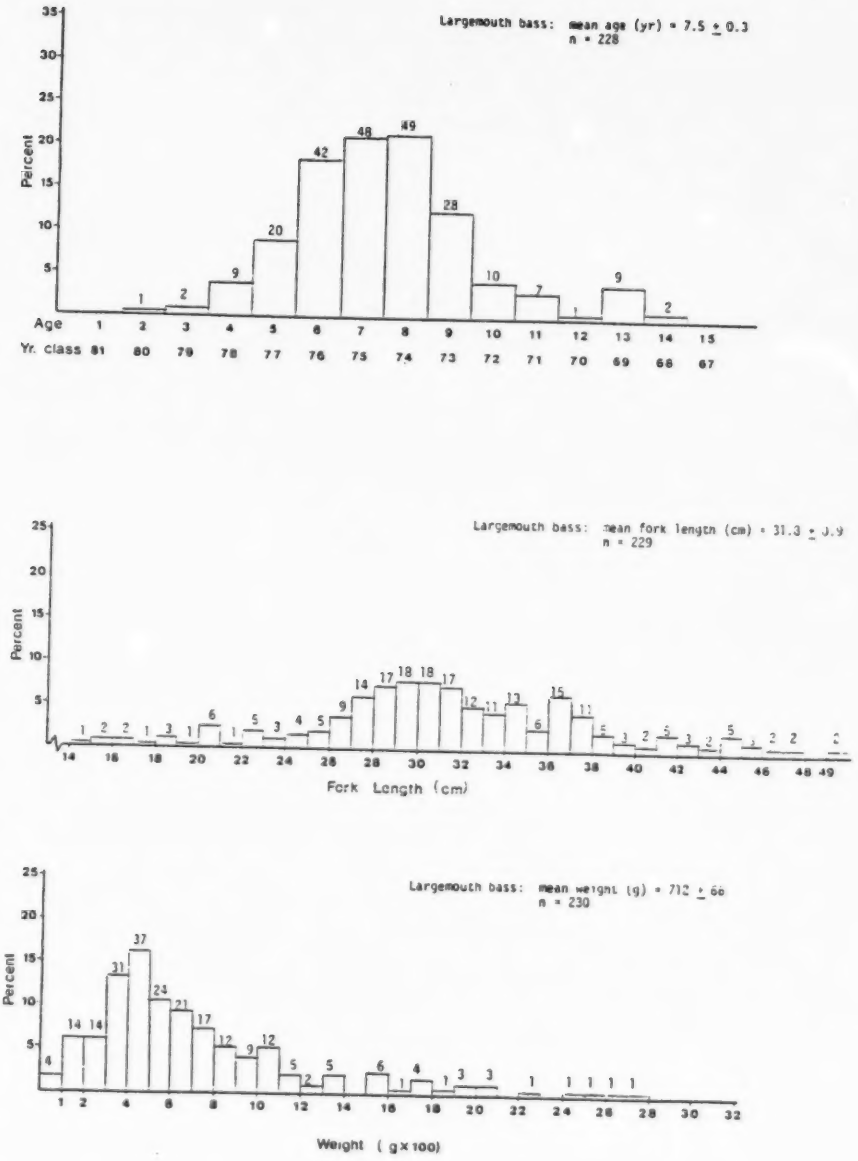

Figure 4.38 Age, fork length, and weight distributions of largemouth bass captured in trapnets at Upper Rideau Lake, 1982. Numbers over each bar indicate actual count frequencies.

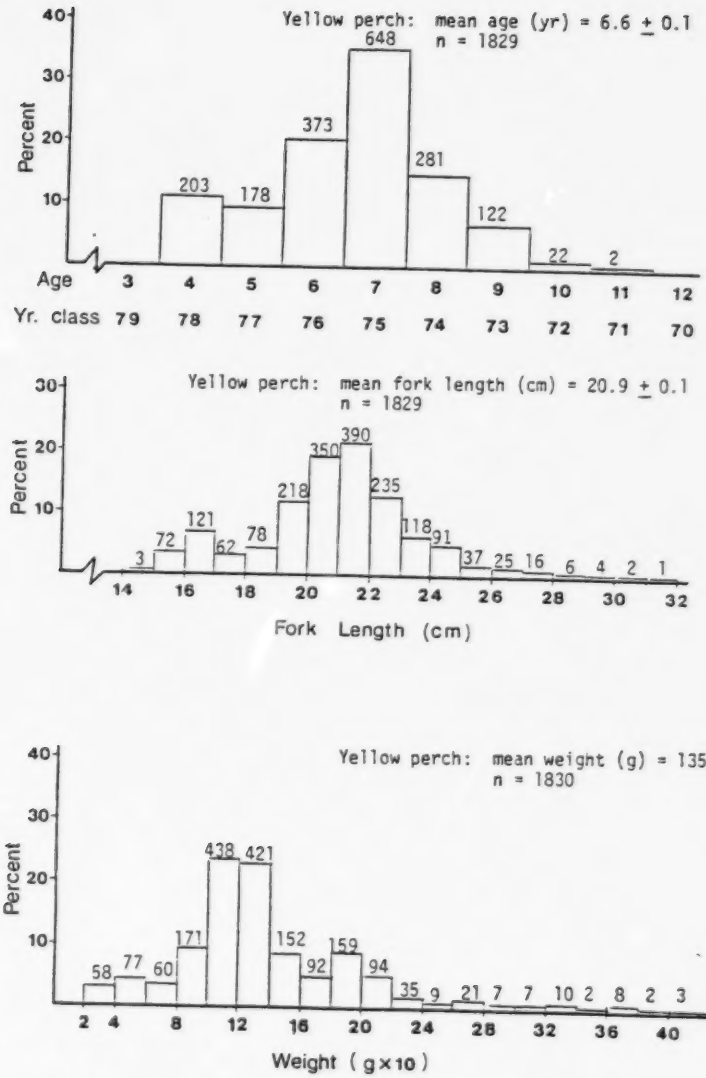

Figure 4.39 Age, fork length, and weight distributions of yellow perch captured in trapnets at Upper Rideau Lake, 1982. Numbers over each bar indicate actual count frequencies.

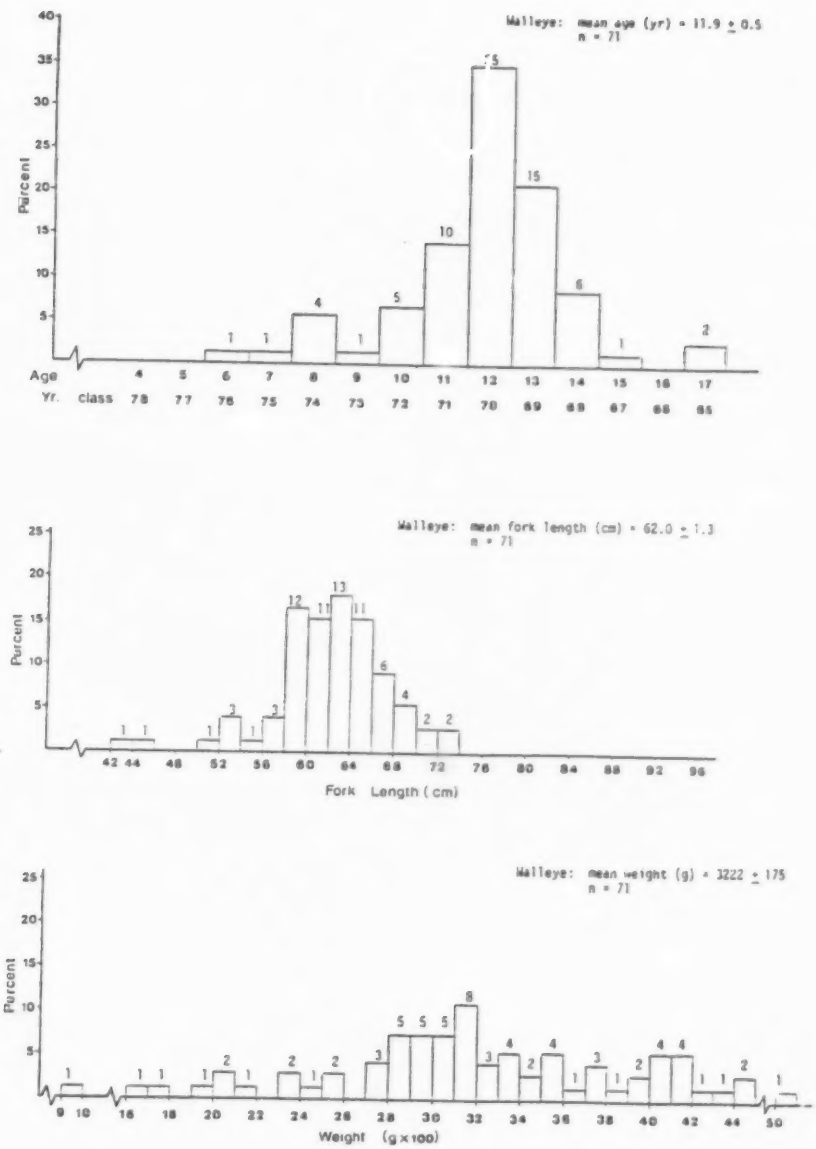
Walleye: mean age (yr) = 11.9 ± 0.5
n = 71
Percent
Age
Yr. class
Walleye: mean fork length (cm) = 62.0 ± 1.3
n = 71
Fork Length (cm)
Walleye: mean weight (g) = 3222 ± 175
n = 71
Weight (g x 100)

Figure 4.40 Age, fork length, and weight distributions of walleye captured in trapnets at Upper Rideau Lake, 1982. Numbers over each bar indicate actual count frequencies.

5. ACKNOWLEDGEMENTS

We would like to acknowledge the valuable contribution of the many RLFAU seasonal staff who assisted with the collection and compilation of field data included in this report: Jim Boraski, Leslie Cronk, George Lilley, Gary Ridout, Dave Schlesinger, and Doug Woods. Garry Smith, RLFAU's Senior Fisheries Technician, coordinated field activities for all studies.

We also thank Karen Stinchcombe, who typed the manuscript, and Scott Barr, who drafted the final figures. Brian Shuter and Nigel Lester's statistical advice was greatly appreciated.

Paul Bewick, Nigel Lester, Ed Paleczny, and Garry Smith provided constructive comments and criticisms of earlier drafts.

6. REFERENCES

Bailey, R.M., J.E. Fitch, E.S. Herald, E.A. Lachner, C.C. Lindsay, C.R. Robbins and W.B. Scott. 1970. A list of common and scientific names of fishes. Third Edition. Am. Fish. Soc. Special Publication No. 6. 150p.

Chamberlain, A.J. 1979. Short-term effects of dock construction activity on fishes in the Nanticoke region of Long Point Bay, Lake Erie. Report 2, Construction phase 2. March - November 1976. Ont. Min. Nat. Res., Nanticoke Fish Study. 50p.

Colby, P.J., R.E. McNicol and R.R. Ryder. 1979. Synopsis of biological data on the walleye, Stizostedion v. vitreum (Mitchill 1818). FAO Fisheries Synopsis No. 119. 139p.

Craig, J.F. and J.M. Fletcher. 1982. The variability in the catches of charr, Salvelinus alpinus L., and perch, Perca fluviatilus L., from multimesh gillnets. J. Fish. Biol. 20: 517-526.

Gale, G.E. and G.A. Goodchild. 1982. Review and reformulation of the relationship between standard conductance and total dissolved solids. Ont. Min. Nat. Res., Environmental Dynamics Section, Fisheries Branch. 41p. + app.

Galluci, V.F. and T.J. Quinn, II. 1979. Reparameterizing, fitting, and testing a simple growth model. Trans. Am. Fish. Soc. 108: 14:25.

Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists. John Wiley and Sons, Toronto, Canada. 257p.

Haedrich, R.L. 1975. Diversity and overlap as measures of environmental quality. Water Research 9: 945-952.

Hamley, J.M. 1975. Review of gillnet selectivity. J. Fish Res. Board Can. 32: 1943-1969.

Hamley, J.M. and T.P. Howley. 1985. Factors affecting variability of trapnet catches. Can. J. Fish. Aquat. Sci. 42: 1079-1087.

Hyslop, E.J. 1980. Stomach content analysis - a review of methods and their application. J. Fish. Biol. 17: 411-429.

Kesteven G.L. (Ed.) 1960. Manual of field methods in fisheries biology. F.A.O. Manuals in Fisheries Sciences, No. 1. F.A.O., Rome. 152.

Laarman, P.W. and J.R. Ryckman. 1980. Size selectivity of

trapnets for eight species of fish. Mich. Dept. Nat. Res., Research Report No. 1880. 15p.

Latta, W.C. 1959. Significance of trapnet selectivity in estimating fish population statistics. Pap. Mich. Acad. Sci. 44: 123-128.

Mabee, P. and M. MacDonald. 1981. Yellow pickerel spawning habitat rehabilatation project. Ont. Min. Nat. Res., Brockville District. Internal report. 66p.

MacLean, N.G. and G.W. Hooper. 1981. Background report. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. Report No. 1. 111p.

MacLean, N.G. and W.G. Smith. 1981a. Five-year operational plan. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. File Report No. 4. 34p.

MacLean, N.G. and W.G. Smith. 1982a. Trapnetting field instructions: Warmwater lakes. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. File Report No. 8. 34p.

1982b. Gillnetting field/lab instruction manual. Warmwater lakes. Ont. Min. Nat. Res., Lakes Fisheries Assessment Unit. File Report No. 10. 18p.

Margalef, D.R. 1968. Perspectives in Ecological Theory. Univ. of Chicago Press, Chicago Ill. 111p.

MacKay, H.H. 1963. Fishes of Ontario. Ontario Dept. Lands and Forests. Bryant Press Ltd., Toronto, Ontario. 300p.

Nichols, S. 1977. On the interpretation of principal components analysis in ecological contexts. Vegetatio 34: 191-197.

Ontario Ministry of the Environment. 1982. Contaminants in fish program. Collection of fish samples for inorganic and organic contaminant analysis. Ont. Min. Env., Internal report. 4p.

Ontario Ministry of the Environment/Ontario Ministry of Natural Resources. 1985. Guide to eating sport fish in Ontario. Ont. Min. Env./Ont. Min. Nat. Res. 254p.

Ontario Ministry of Natural Resources. 1982. Summary of the fishing regulations. Ont. Min. Nat. Res., Fisheries Branch.

1983. The identification of overexploitation. Report of SPOF working group number fifteeen. Strategic Planning for Ontario Fisheries. Ont. Min. Nat. Res., Policy development. 84p.

Pope, J.A., A.R. Margetts, J.M. Hamley, and E.F. Akyuz. 1975. Manual of methods for fish stock assessment. Part III. Selective of fishing gear. F.A.O. Fish. Tech. Pap. 41p. Rev. 1. 65p.

Priegal, G.R. 1970. Reproduction and early life history of the walleye in the Lake Winnebago region. Tech. Bull. Wisc. Dep. Nat. Res., 45: 105p.

Ricker, W.E. 1969. Effects of size-selective mortality and sampling bias on estimates of growth, mortality, production and yield. J. Fish. Res. Board Can. 26: 479-541.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin Fish. Res. Board Can. No.:191. 382p.

Rideau Lakes Fisheries Assessment Unit. 1982. Zooplankton sampling results. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. File data.

Schlesinger, D.A., G.E. Ridout, and N.G. MacLean. 1984. The sport fisheries of Long, Mica, Opinicon, Sydenham, and Upper Rideau Lakes, 1982. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. Report No. 9. 60p.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Board Can. Bull. 184. 966p.

Smith, W.G. and N.G. MacLean. 1985. Water quality assessment of Long, Mica, Opinicon, Sydenham and Upper Rideau Lakes. Ont. Min. Nat. Res., Rideau Lakes Fisheries Assessment Unit. Report No. 14. 60p.

Sokal, R.R. and F.J. Rohlf. 1969. Biometry. The principles and practice of statistics in biological research. W.H. Freeman and Company. San Francisco. 776p.

Sprules, W.G. 1977. Crustacean zooplankton communities as indicators of limnological conditions: an approach using principal component analysis. J. Fish. Res. Board. Can. 34: 962-975.

Steele, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistis. A Biometrical Approach. McGraw-Hill, Toronto, Ontario. 633p.

Tonn, W.M., J.J. Magnuson and A.M. Forbes. 1983. Community analysis in fishery management: An application with northern Wisconsin lakes. Trans. Am. Fish. Soc. 112: 368-377.

Vaughan, D.S., and W. Van Winkle. 1982. Corrected analysis of the ability to detect reductions in year class strength of

the Hudson River white perch (Morone chrysops) population. Can. J. Fish. Aquat. Sci. 39: 782-785.

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